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Particulate Data Reduction (PADRE) System Reference Manual

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PARTICULATE DATA REDUCTION (PADRE) SYSTEM REFERENCE MANUAL

by

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16. ABSTRACT The report describes how to access and use the Particulate Data Reduction (PADRE) System, an interactive computer program that facilitates entry, reduction, and analysis of cascade impactor data for particle size distributions. It also summarizes its logic and capabilities. The program narrative describes all calculations and algorithms and all messages produced by the system. PADRE was developed to ensure the quality of data included in the Fine Particle Emissions Information Systems (FPEIS), a component of the Environmental Assessment Data Systems (EADS). Users control the logical flow through the system in response to prompts from the program. PADRE can be used to store, review, edit, and analyze data and, through a variety of data checks, to identify invalid or suspect data. Impactor stage cut points are calculated, and cumulative and differential mass concentrations are determined and interpolated to standard diameters.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Data Reduction	Stationary Sources	09B
Dust	Particulate	11G
Impactors	Cascade Impactors	13I
Particle Size Distribution	Environmental Assessment	14G
Assessments		14B

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This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

ABSTRACT

The Particulate Data Reduction (PADRE) system is an interactive computer program that facilitates entry, reduction, and analysis of cascade impactor data for particle size distributions. PADRE was developed to ensure the quality of data included in the Fine Particle Emissions Information Systems (FPEIS), which is a component of the Environmental Assessment Data Systems (EADS). Users control the logical flow through the system in response to prompts from the program. PADRE can be used to store, review, edit, and analyze data and, through a variety of data checks, to identify invalid or suspect data. Impactor stage cut points are calculated and cumulative and differential mass concentrations are determined and interpolated to standard diameters. This document describes how to access and use PADRE and summarizes its logic and capabilities. The program narrative describes all calculations and algorithms and all messages produced by the system.

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SECTION 1

INTRODUCTION

PURPOSE

This report describes the functions of the PArticulate Data REduction (PADRE) system. It documents all calculations and algorithms and is the technical reference for the system.

The purpose of the PADRE system is to facilitate entry of validated cascade impactor data from representative in-stack runs into the Fine Particle Emissions Information System (FPEIS),[1] which is a major component of the Environmental Assessment Data Systems (EADS). Cascade impactor data can be entered, reduced, and compared through PADRE. Reduction of observed data to determine the effective stage cut diameters as well as the cumulative and differential mass concentrations takes only a few seconds; this capability permits test plans or operating conditions to be modified during a test to optimize data quality. Data entered through PADRE are not automatically included in FPEIS; the test contractor is expected to designate representative runs after he has validated the data.

HISTORY

Cascade Impactor Data Reduction System (CIDRS)

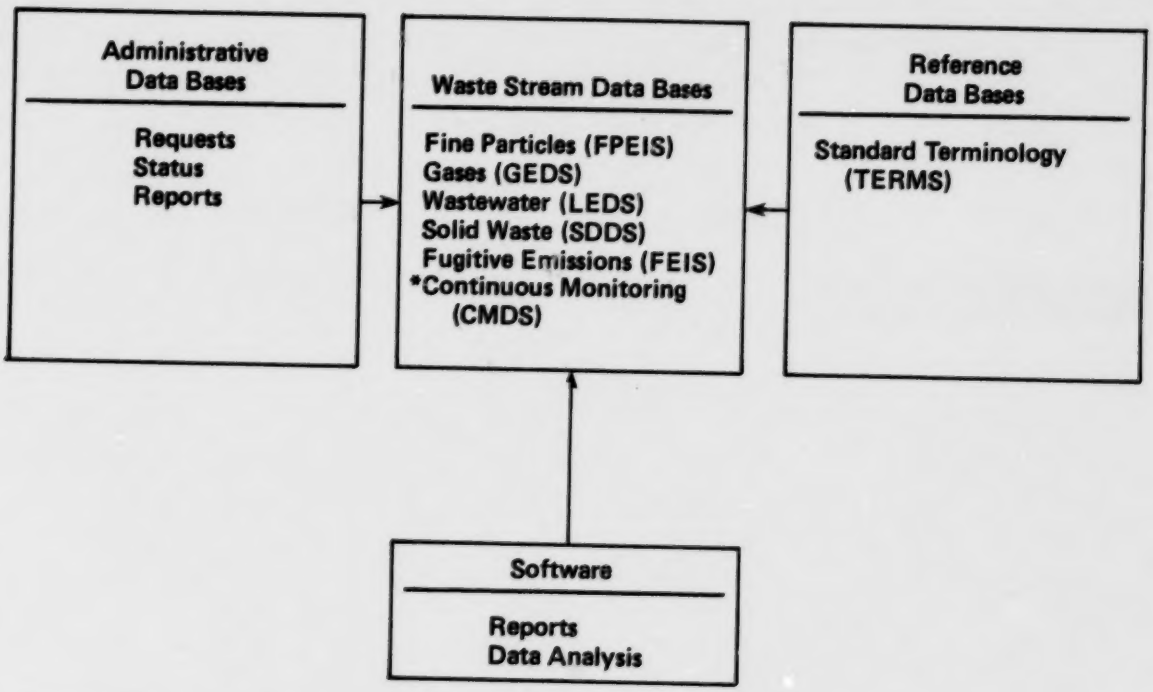
Data reduction is based on the CIDRS computer programs developed by the Southern Research Institute (SoRI).[2] CIDRS may be used to reduce data for individual impactor runs and to plot results of one or more runs. It can average and statistically analyze multiple runs and calculate (and plot) penetration/efficiency vs. size distributions for control device performance. PADRE allows data reduction from a wider variety of impactor types and configurations than does CIDRS. Additionally, PADRE is interactive, which facilitates data input and allows rapid analysis of impactor data by novice computer users.

Environmental Assessment Data Systems (EADS)

FPEIS[3] was developed in the mid 1970's and became fully operational in January 1977. During this period, the mission of EPA's Industrial Environmental Research Laboratory at Research Triangle Park (IERL-RTP), North Carolina was broadened from focusing on air emissions and associated control technology research and development (R&D) to encompass multimedia (e.g., air, water, and solid) discharges from a wide range of energy and industrial processes. In response to these changes, IERL-RTP began to develop a series of data bases modeled on the FPEIS concept that would be capable of reporting multimedia discharge information uniformly and consistently. This work resulted in EADS[4], which is both a resource for producing evaluated information and an environmental data repository (see Figure 1). Its structure, as Figure 2 shows, permits full characterization of all data with minimum redundancy.

A greatly expanded version of the FPEIS was incorporated into the EADS, and data acquisition activities beginning in 1979 were directed toward data entry to the EADS/FPEIS data base. During this time, anticipating its proposal of a revised national ambient air quality standard (NAAQS) for particulate matter based upon particle size, EPA began to compile a technical data base for developing particulate emission factors as a function of particle size. Principal responsibility for data-gathering activities was given to IERL-RTP. The EADS/FPEIS was recognized as the mechanism by which data handling and analysis could be achieved most cost effectively. Acquisition of existing particle size data has accelerated and is supplemented by a comprehensive source testing program under IERL-RTP's direction.

After the loading of new source test data, the EADS/FPEIS data base will be used as a primary resource to produce "inhalable" and respirable particle emission factors. Inhalable particles (PM_{10}) are less than or equal to 10 μm in diameter, while respirable particles are less than or equal to 2.5 μm in diameter. While the size of the currently defined inhalable particles may change, the PADRE program is flexible enough to accommodate any change in the sizes of interest.



*Planned or proposed EADS components.

Figure 1. Environmental Assessment Data Systems (EADS) overview.

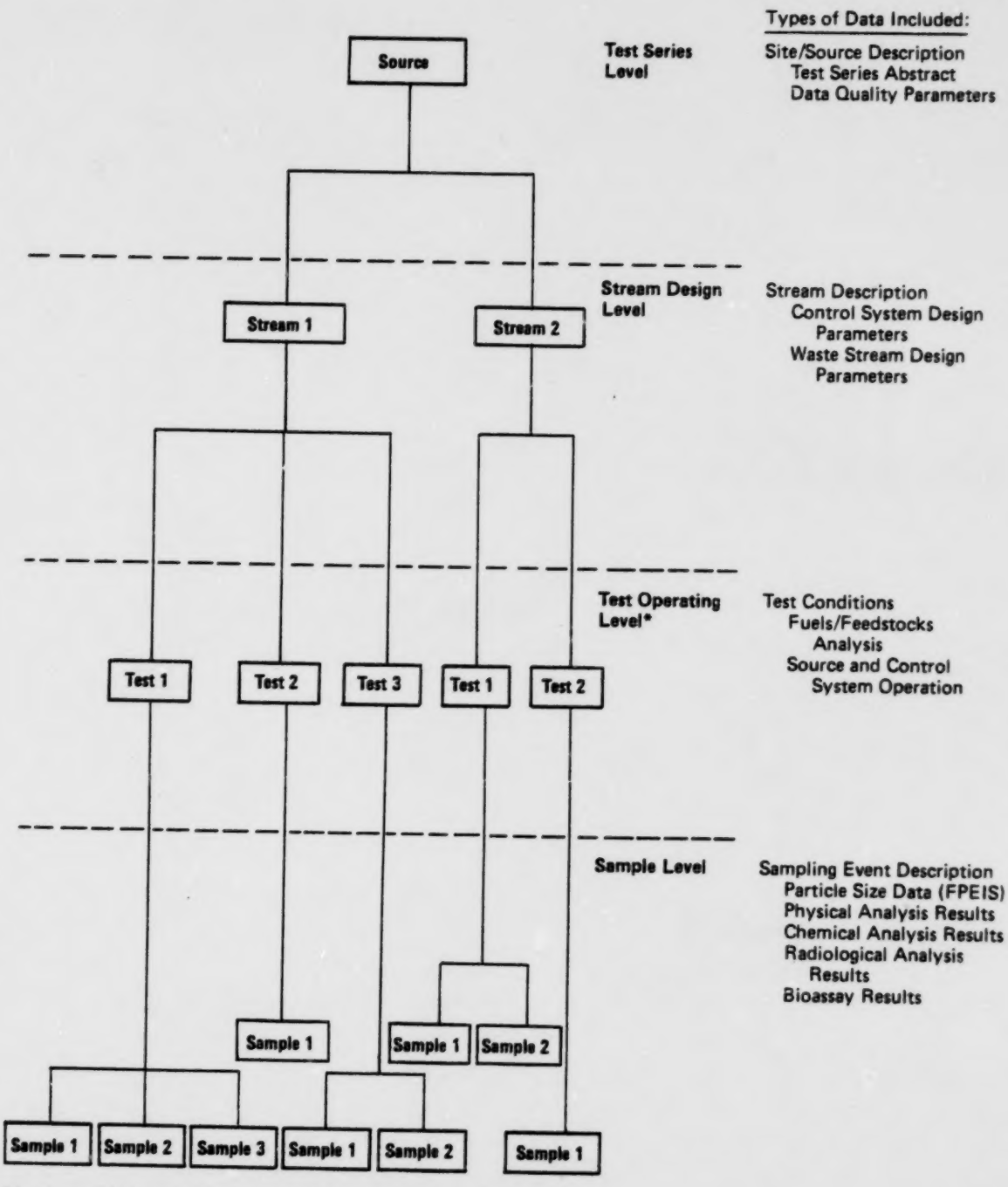


Figure 2. EADS data organization.

DOCUMENT ORGANIZATION

Section 2 of this guide gives an overview of the PADRE system, the data organization, and the data processing. Section 3 describes prerequisites for accessing PADRE; i.e., what the user must do to begin. Section 4 provides operating instructions. For users interested in greater detail, Section 5 describes the logical flow of control of the PADRE system's more important routines and includes equations and algorithims used in the various calculations. Appendix A contains flowcharts of selected routines and, Appendix B contains a variety of sample sessions that illustrate PADRE's uses and capabilities.

SECTION 2

OVERVIEW

DATA ORGANIZATION

Data organization and terminology are as consistent with EADS/FPEIS as possible (see Figure 2). Thus, for PADRE several impactor runs (samples for EADS/FPEIS) are logically connected to one test, with specification of the stream and operating levels embedded within the run data records. In particular, all runs for a given test share a common site and particle density and begin on or after that test date. PADRE utilizes user-specified keys (described below) to access all stored data. Three data categories may be entered by PADRE users: weight data, test data, and run data. A fourth category, impactor data, must be supplied to the EPA Project Officer before data can be reduced.

- Weight data include a description of the substrates, pre-weights for each substrate, and post-weights for each substrate. Net weights are calculated from pre-weights and post-weights. Substrate pre-weights are entered into the system independently of run data. PADRE will assign a substrate's ID number when the pre-weights are first entered; users must specify this ID number when they enter run data.
- Test data are the same for all test runs. These include the test comments, (assumed) particle density, site code, and test date.
- Run data include run comments, operating conditions, identification of impactor used, and ID number of the set of substrates used in the impactor.
- Impactor data include brand name, model, serial number, calibration date, and number of stages. For each stage, the number of jets, average jet diameter, Stokes' number, and cumulative fractional pressure drop are required.

Data are entered and stored in units where they are commonly observed to facilitate data entry and correction.

DATA PROCESSING

PADRE involves four processes:

- data entry
- data reduction
- data comparison
- data designation

In the entry process observable data are read from an interactive computer terminal operated by the user. These data may then be reviewed and modified. In the reduction process, effective cut points (stage D_{50}'s) and mass concentrations for each impactor stage are computed under actual operating conditions. Mass concentrations are interpolated to standard intervals. In the comparison process, data from several user-specified runs are reduced and statistics at each standard diameter are computed. In the designation process, observable data from user-specified runs are printed in the format of EADS data input forms. The user may submit these forms to EPA to include data in the EADS.

Figure 3 is a diagram of the PADRE system showing the relationship of each of these processes to the data sources and data files. Such a diagram has four elements: (a) data represented by arrows with the name(s) of the data they represent, (b) processes represented by circles, (c) files represented by straight lines, and (d) sources and sinks of data represented by rectangles.

Figure 3 has only two data sources--the PADRE user (test contractor), and the PADRE support staff which reports to the EPA Project Officer. The user interactively supplies weight data, test data, run data, selection criteria (test or run keys), and comments. The user receives a data review report, an abbreviated analysis report, an expanded analysis report, a run comparison report, and FPEIS coding forms. The support staff receives impactor description and calibration information from the users (independently of the PADRE system) and loads it into the impactor description file for reference by PADRE. The support staff also receives comments from users through the comments file.

Four data files are associated with the PADRE system. The weight file contains weight data. The trial data file contains test data and run data. The impactor description file contains descriptive data and calibration constants for specific cascade impactors. The comments file contains comments from PADRE users concerning the system and its documentation.

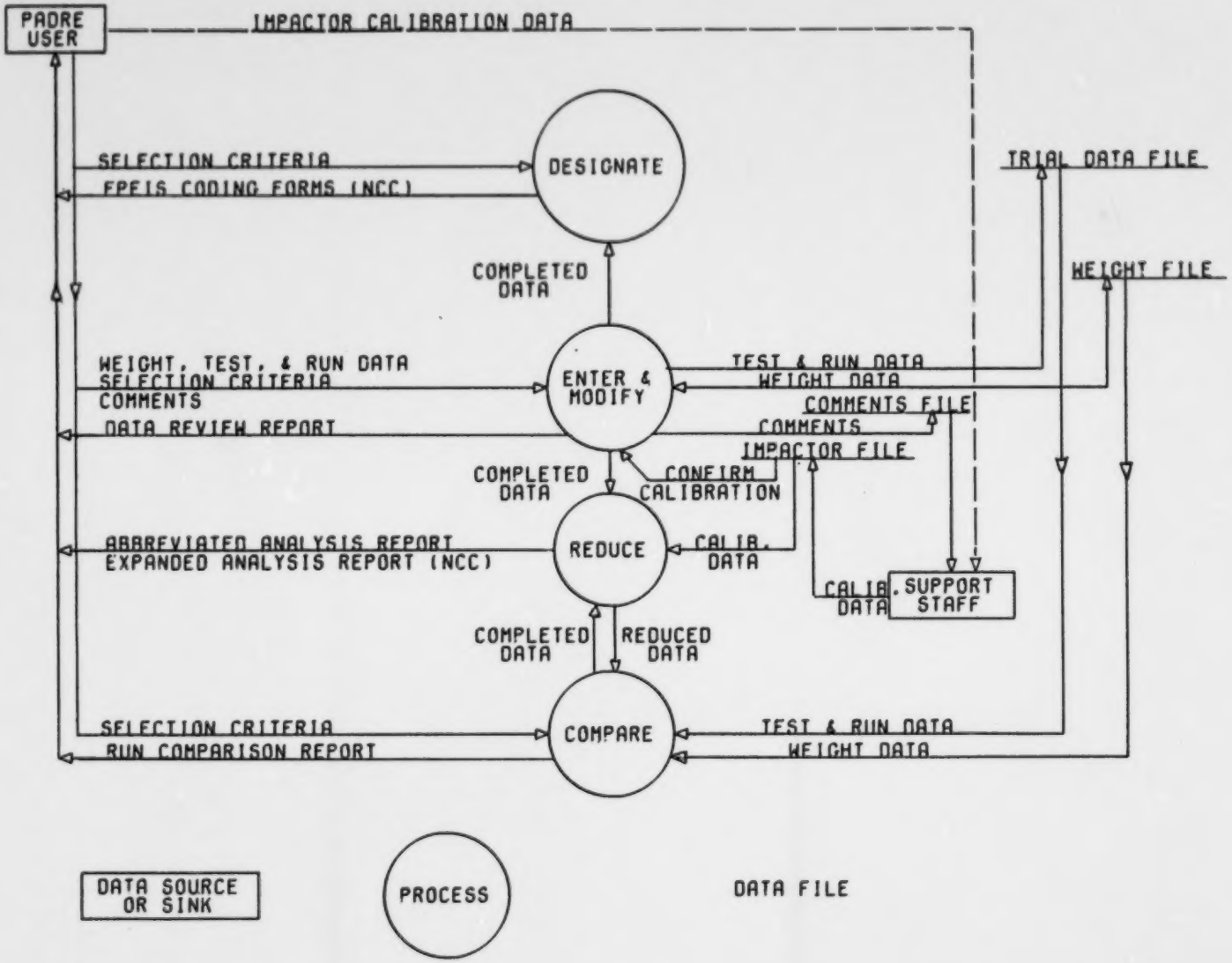


Figure 3. PADRE system diagram.

Data Entry

Data input--

The user is prompted for each data item. The prompt includes a description of the datum and variable name PADRE assigns the datum; e.g., ENTER IMPACTOR TEMPERATURE, TIMP (DEG F). This variable name (TIMP) may be used later to update the datum if an error is detected. After all data in a category (weight, test, run) have been entered, they are printed for user review and validation.

Internal data checks--

Before data are stored, PADRE checks for several types of errors. If numerical data are expected, nonnumerical data are rejected immediately and the user is asked to reenter numerical data. Negative particulate weights are detected as soon as the substrate post-weight is entered; the user is immediately offered an opportunity to correct the post-weight.

After all data for a new impactor run have been entered, as many values as possible are checked by PADRE. Inconsistent or suspicious values (outside the normal range) cause warnings to be printed at the terminal and on the expanded output. These warnings are preceded by three asterisks. Warning messages and their corresponding conditions are listed in Table 1. These checks are performed whenever data are entered, retrieved, or modified. Actual operating conditions for a test may include some valid values outside the normal range, which will produce warnings that can be safely ignored. However, the user should review carefully all warnings and assure himself that corresponding data are correct.

Within data reduction procedures, some data are critical. For example, if a variable is used as a divisor, a zero value will cause program termination beyond PADRE's control. If PADRE detects an invalid value for a critical variable, the run is marked as containing dangerous data. An error message preceded by five asterisks is printed on the terminal as well as on the expanded output. Error messages and their corresponding conditions are listed in Table 1. These checks are performed whenever data are entered, retrieved, or modified. When a user retrieves a run that contains one of these errors, he may only list or modify it. The data reduction process can only be requested for "clean" data. Processes that require reduced data,

TABLE 1. PADRE's Internal Data Checks

Message	Condition
*** AMBIENT PRESSURE, nn.nn, IS LOW	PAMBNT < 25.0 in Hg
*** AMBIENT PRESSURE, nn.nn, IS HIGH	PAMBNT > 35.0 in Hg
*** CO2 COMPONENT OF STACK GAS IS INVALID	$\%CO_2$ < 0
*** CO2 COMPONENT < 20%	$\%CO_2$ > 20.0
*** CO COMPONENT OF STACK GAS IS INVALID	%CO < 0
*** CO COMPONENT > 10%	%CO > 10.0
*** CUT POINTS FOR STAGES n, m ARE SIMILAR OR INVERTED	cut point (n) < 1.4 cut point (m)
MEASURED DATA FOR STAGE m WITH D50= n.nn OMITTED FROM INTERPOLATION	
***** CYCLONE CUT POINT, CYCL, > 20 MICRONS	CYCL > 20.0 μ
***** FINAL GAS VOLUME, nnn.n < INITIAL VOLUME, nnn.n	GMVOLF < GMVOLI
*** GAS COMPONENTS NORMALIZED SO THAT SUM= 100%, NOT nn.n	sum of dry gas components ≠ 100.0
*** H2O COMPONENT OF STACK GAS IS INVALID	$\%H_2O$ < 0.0
*** H2O COMPONENT > 50%	$\%H_2O$ > 50.0
*** IMPACTOR TEMP., TIMP, SHOULD BE > STACK TEMP., TSTACK	TSTACK > TIMP
*** IMPACTOR TEMP., TIMP, SHOULD BE < 500	TIMP > 500 °F
*** INTERPOLATED CUMULATIVE MASS DECREASES BETWEEN n.nn AND m.mmm MICRONS	interpolated cum. mass not monotonic
*** INTERPOLATED VALUES NORMALIZED TO ACCOUNT FOR OMITTED MASS ON FILTER-	FLARGE = YES
*** JET VELOCITY FOR STAGE n IS HIGH	jet velocity > 50 m/s
*** LARGE PARTICLES ON FILTER INDICATE PARTICLE BOUNCE OR REENTRAINMENT. SIZE DISTRIBUTION MAY BE DISTORTED	FLARGE = YES
*** MASS ON CYCLONE IS LOW	mass < 0.1 mg
*** MASS ON STAGE n IS HIGH	mass > 10.0 mg
*** MASS ON STAGE n IS LOW	mass < 0.1 mg
*** MAX. PARTICLE DIAM., DMAX, IS LARGE	DMAX > 100 μ
***** MAX. PARTICLE DIAM., DMAX, SHOULD BE > 30	DMAX < 30 μ
*** N2 COMPONENT > 90%	$\%N_2$ > 90.0
*** N2 COMPONENT OF STACK GASE MAY BE INVALID	$\%N_2$ < 60
***** NET WEIGHTS HAVE NOT BEEN CALCULATED	AMASS (1) ≤ 0.0
***** NO RECORD FOR IMPACTOR iiiiii, PLATE SET ppp IN DESCRIPTION FILE	No record in impactor description file for specified impactor
*** NON-STANDARD CUT POINT, n.nn BELOW 1ST MEASURED CUT POINT, m.mm	ACUTPT < cut point for last stage
*** NON-STANDARD CUTPT nn.n > MAX. PARTICLE DIAM., mm.m	ACUTPT (I) > DMAX
***** NOZZLE CUT POINT = nn.nn < mm.mm = CYCLONE CUT POINT	CUTNOZ < CYCL
*** NOZZLE DIAMETER, DNOZZ <= 0	DNOZZ <=0.0
***** NOZZLE DIAMETER, DNOZZ > 1 IN.	DNOZZ > 1.0 inch
***** NO. OF WEIGHTS, n, INCONSISTENT WITH SPECIFIED IMPACTOR CONFIGURATION	NMASS not consistent with NSTAGE, backup filter (if used)
***** NUMBER OF STAGES USED, nn, INCONSISTENT WITH IMPACTOR DESCRIPTION	NS ≠ NSTAGE
*** O2 COMPONENT OF STACK GAS IS INVALID	$\%O_2$ < 0
*** O2 COMPONENT > 23%	$\%O_2$ > 23.0
*** IMPACTOR TEMP., TIMP, SHOULD BE < 500	TIMP > 500 °F
*** PARTICLE DENSITY, n.nn, IS LOW	RHO ≤ 1.0 g/ml
*** PARTICLE DENSITY, n.nn, IS HIGH	RHO ≥ 4.0 g/ml
*** RELATIVE STACK PRESSURE, n.nn, IS LOW	PSTACK < 15.0 in Hg
*** RELATIVE STACK PRESSURE, n.nn, IS HIGH	PSTACK > 40 in Hg
***** RHO SHOULD BE POSITIVE, NOT n.nn	RHO < 0.0
***** RTYPE MUST BE I OR O, NOT c	RTYPE neither 'I' nor 'O'
*** RUN DATE mmddyy BEFORE CALIBRATION DATA mmddyy	IDATE < CDATE
*** RUN DATE mmddyy BEFORE TEST DATA mmddyy	JDATE < IDATE
*** SAMPLING DURATION, nn.n, IS SHORT	DUR < 3.0 min
*** SAMPLING DURATION, nn.n, IS LONG	DUR > 1000.0 min
*** SAMPLING IS AT nn.n% OF ISOKINETIC RATE	PCISOK < 90.0
*** STACK GAS VELOCITY, VSTACK, <= 0	VSTACK ≤ 0.0 ft/s
*** STACK GAS VELOCITY, VSTACK, > 100 FT/SEC	VSTACK ≥ 100 ft/s
*** STACK TEMPERATURE, nnn.n, IS LOW	TSTACK < 30 °F
*** STACK TEMPERATURE, nnn.n, IS HIGH	TSTACK > 500.0 °F
*** START TIME CANNOT BE NEGATIVE	ISTART < 0
*** START TIME MUST BE LESS THAN 2400	ISTART > 2400
***** SUM OF THE COMPONENT PERCENTAGES IS NOT 100	95% < SUM < 101%
*** VOLUME OF WATER COLLECTED, VOLH2O < 0	VOLH2O < 0.0
*** VOLUME OF WATER COLLECTED, VOLH2O > 1000 ML	VOLH2O > 1000.0 ml

Note: *** prefixes warnings; ***** prefixes errors which will preclude data reduction.

(e.g., comparison of runs or calculation of control device efficiency) also are prohibited.

The purpose of the data reduction process is to detect incorrect, although apparently reasonable, observable data. Unreasonable reduced data probably indicate incorrect observable data. While the user is the final arbiter of what is unreasonable, PADRE checks some of the reduced data and warns the user of potential problems. Conditions that will produce such warnings include, but are not limited to, the following:

- Jet velocity > 50 m/s
- Cut points separated by < 40 percent
- Nonmonotonic interpolated cumulative mass concentrations.

Data storage--

All data entered through PADRE are stored in FORTRAN direct-access files, which are used only by PADRE. Weight data are stored separately from test data and run data, which allows the pre-weights of several sets of conditioned substrates to be entered before a test begins. The PADRE system assigns a numeric key, or substrate's ID number, to the weight record when the user indicates that he wishes to enter a new set of weights. The key is printed with a reminder to the user to record it for later reference. This key must be specified to retrieve the weight record for completion with post-weights or for reference by the run record.

Test data and run data are stored in the same record in the trial data file. This record also includes the key to the corresponding weight record. Records in the trial data file are referenced with four user-supplied keys: user code, site code, test date, and run number. PADRE determines the user code from the Run-ID field of the @RUN statement at the beginning of the session (see figure 7). The site code and test date are specified by the user when he enters the test data. These codes are the same for all runs in a test. PADRE assigns the run number when the user indicates he wishes to enter data for a new run.

Whenever PADRE stores data, it prints a message with the record keys; e.g.,

SUBSTRATE DESCRIPTION, WEIGHTS SAVED IN RECORD nnn

DATA FOR RUN n BY ccc AT ssss ON mmddyy HAS BEEN SAVED IN THE TRIAL DATA FILE

*** RECORD THESE VALUES IN YOUR NOTEBOOK

Data review--

Data for a run may be reviewed at any time. An important feature of the data review report is that all observable data are printed on the terminal, along with the impactor calibration data, allowing users to validate the data they have entered. It also documents all data that will be used in the reduction process.

Data correction--

The user is prompted with a list of variable names printed on one line. If the user wants to update one or more of the corresponding data, he spaces across the line and enters any character under the variable names(s). The system then prompts the user for a new value of each variable the user marked for update.

ENTER A MARK UNDER EACH VARIABLE YOU WISH TO MODIFY OR RETURN.
PAMBNT DPSTK TSTACK TIMP DMAX CYCL PCTINY

When the user has bypassed an opportunity to update all data in the run, current values are printed for review and the user is asked whether he wishes to make further updates. If the user responds negatively, data are stored; otherwise, the entire update cycle is repeated.

Data Reduction

Once the data have been validated, PADRE can determine quickly the effective cut points (D_{50}'s) for each stage of the impactor as well as the mass and number concentrations. These concentrations are then interpolated to standard diameters to facilitate comparison with data from other runs using different impactors, or with data from runs for the same impactor under different operating conditions.

Although PADRE will not allow data reduction unless post-weights have been entered, if dummy post-weights (e.g., 1 mg > corresponding pre-weight) are entered, PADRE may be run as soon as the operating conditions are known. This will show whether any pair of cut points is too close or inverted, especially useful when an impactor is configured with a cyclone precutter.

PADRE performs data reduction using three definitions of diameter: (1) physical [Stokes'], (2) aerodynamic or Task Group on Lung Dynamics [TGLD],[5] and (3) aerodynamic impaction [Mercer's].[6] For each definition, the user may request output at the terminal. This abbreviated analysis report includes the total mass loading and the maximum observed particle diameter for the run. The mass, mass concentration, cumulative mass concentration, effective cut point, geometric mean diameter, differential mass concentration and differential number concentrations are printed for each stage. These mass concentrations are interpolated to standard diameters (20.0, 15.0, 10.0, 6.0, 2.5, 1.25, 0.625, 0.3, and 0.1 μm). Interpolation is only performed within the range of observed data, e.g. if the smallest measured D_{50} is 1.0, no values at standard diameters 0.625, 0.3, and 0.1 μm can be interpolated.

In addition to the abbreviated analysis report on the terminal, a more complete expanded analysis report (see sample session 7 in Appendix B) is generated for the line printer at EPA's National Computer Center (NCC). At the end of the data reduction procedure, the user may request that this expanded output be printed and mailed to him. Otherwise, the expanded output will be deleted at the end of the run. Note that the user need request expanded output only once to mark the expanded output file for printing; that file will contain all expanded output for the entire session.

Data Comparison

Data for all or several selected runs in a test may be retrieved and reviewed with a one-line summary for each run. Data for inlet or outlet runs may be reduced and compared in a common, uniform format. For a user-specified definition of diameter, univariate statistics on cumulative or differential mass concentrations at each standard diameter may be calculated. Outliers are noted for inspection. Also, penetration/efficiency calculations at standard diameters may be performed.

Designation of Runs for FPEIS

When the user is satisfied that the data are correct, he may select representative runs for inclusion in FPEIS. PADRE will print the observed data on a line printer at NCC in the format of EADS data entry forms 6 and 7a. This output will be mailed to the user, who should add the remaining EADS forms with the unique Test Series Number and all other required data. Cards punched from these forms should be sent to the EADS Program Manager, who will then process them through the FPEIS data review cycle to check for protocol errors. Runs included in the FPEIS will be deleted automatically from PADRE's trial data file. The FPEIS Users Guide[1] documents an extensive library of programs that can be used to access the particle data and to produce a variety of reports.

SECTION 3

PREREQUISITES

APPROVAL OF EPA

The PADRE system was developed under EPA Contract No. 68-02-3146 and is installed at EPA's National Computer Cente. (NCC) on the UNIVAC 1100/83 computer. The system may be made available to all users of cascade impactors: EPA personnel, EPA contractors, and State agencies, as well as commercial and consultant impactor users. EPA provides this resource tool to analyze cascade impactor data with the understanding that users will share validated data from representative runs by submitting them for inclusion in the EADS/FPEIS data base.

Three items of information are required for NCC access--a User-ID, a Run-ID, and an account number. A three-character code assigned by the NCC (frequently the user's initials), the User-ID uniquely identifies each user. Associated with each User-ID is a password, which each user chooses and must change at least every 90 days.

The Run-ID serves several functions for both PADRE and NCC. It is a five-character code. The last three characters must be the user code, one of the keys by which test data and run data are stored and retrieved. The NCC staff also uses the Run-Id to identify to whom PADRE output printed at NCC should be sent. The user code is assigned by the EPA Project Officer.

The account number is provided by the NCC to all users meeting the criteria for using the NCC. Potential users should contact the Project Officer to determine if they can qualify for an NCC account.

DATA

While new users are encouraged initially to practice with PADRE using artificial or sample data, it is assumed that most users will be using actual data from in-stack impactors. PADRE is no substitute for a careful record of all operating conditions and observed data. New users may wish to transcribe these data to PADRE data entry forms (see Figures 4, 5, and 6). This procedure will help users become familiar with the variable names and brief descriptions used in the prompts, prepare users for the order of the prompts, and ensure that all necessary data have been recorded.

Calibration constants for the user's impactor are required in order to calculate the D_{50}'s. These may be submitted to the Project Officer before the PADRE system is used, so they will be available to the system when the impactor configuration is specified. These constants include:

- Scale factor for pressure drop,
- Number of holes in each stage,
- Average diameter of the holes,
- Fractional cumulative pressure drop across each stage, and
- Stokes' constant (Ψ_{50}) for each stage.

The calibration date also is required. Calibration information for a specific impactor is sought by the impactor type (e.g., Andersen and Brink), the impactor model (e.g., Mark III), and a unique number assigned to the set of plates used in the calibration run. If the user does not know the calibration constants for his impactor but wants to conduct preliminary analyses, he may specify the impactor type and model with plate set ID zero to access "generic" calibration constants. The validity of the D_{50}'s will, of course, depend on how closely his impactor corresponds to the mythical impactor the generic calibration constants describe.

TERMINAL

Access to PADRE requires an interactive computer terminal. All program printed lines contain less than 80 characters. Any terminal that can access the NCC in Research Triangle Park, North Carolina, may be used, but one that produces a permanent "hard copy" to document the PADRE session is recommended.

The basic requirement is that the terminal emulate a teletype at 30 or 120 characters per second and handle computer communications with even parity. PADRE has been developed in anticipation that a field-portable terminal like a Texas Instruments "Silent 700" (e.g., Model 745) would be used. However, any terminal that emulates a teletype may be used.

Substrates ID (assigned) _____ _____ _____ _____
Description _____ _____ _____ _____
No. of weights _____ _____ _____ _____

Units of all weights should be milligrams. Order should be from largest particles to smallest particles; first stage, ..., last stage, backup filter (if used).

1. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
2. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
3. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
4. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
5. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
6. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
7. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
8. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
9. Pre-weight _____ _____ _____ _____
   Post-weight _____ _____ _____ _____
10. Pre-weight _____ _____ _____ _____
    Post-weight _____ _____ _____ _____

Figure 4. PADRE data entry form: weight data.

Contractor ID, CNRTR:_____ Site ID, SITE:_____ Test Date, IDATE:_____

Test Comments, TCOMM_____
Assumed particle density, RHO_____g/ml

Run index, IRUN (assigned)	_____	_____	_____
Run comments, RCOMM	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Run date, JDATE	_____	_____	_____
Start time, ISTART	_____	_____	_____
Duration, DUR (min)	_____	_____	_____
Run type, RTYPE	_____	_____	_____
% H_2O in stack gas	_____	_____	_____
Composition of dry stack gas			
% CO_2	_____	_____	_____
% CO	_____	_____	_____
% N_2	_____	_____	_____
% O_2	_____	_____	_____
Ambient pressure, PAMBNT (in. Hg)	_____	_____	_____
Stack P wrt ambnt, DPSTK (in. H_2O)	_____	_____	_____
Stack temperature, TSTACK (°F)	_____	_____	_____
Stack gas velocity, VSTACK (ft/s)	_____	_____	_____
Impactor temperature, TIMP (°F)	_____	_____	_____
Flow rate determination method	_____	_____	_____
if EPA method 5, then			
initial gas vol., GMVOLI (ft^3)	_____	_____	_____
final gas vol., GMVOLF (ft^3)	_____	_____	_____
volume water collected, VOLH_2O (ml)	_____	_____	_____
temp. of meter, TMETER (°F)	_____	_____	_____
meter calibration factor CMETER	_____	_____	_____
orifice ΔP, DPORIF (in. H_2O)	_____	_____	_____
else			
impactor flow rate, FLOW (ft^3/min)	_____	_____	_____
Max. particle dia., DMAX (microns)	_____	_____	_____
Cyclone cut point, CYCL (microns)	_____	_____	_____
Nozzle diameter, DNOZZ (in.)	_____	_____	_____
Nozzle cut point, CUTNOZ (microns)	_____	_____	_____
Was backup filter used? BF	_____	_____	_____
Large particles on filter? FLARGE	_____	_____	_____
Impactor type, IMPNAM	_____	_____	_____
Impactor model, IMPMOD	_____	_____	_____
Impactor plate set ID, IPLATE	_____	_____	_____
Number of stages used, NS (Do not count cyclone or backup filter)	_____	_____	_____
Substrates ID, IDSUBS (assigned)	_____	_____	_____

Figure 5. PADRE data entry form: run data.

Impactor type, IMPNAM _____

Impactor model, IMPMOD _____

Impactor plate set ID, IPLATE _____

Calibration data CDATE _____

Number of stages, NSTAGE _____

Scale factor, SCALE _____

Stage	No. holes NJETS	Avg. hole diameter DJETS (cm)	Cumulative fractional pressure drop CUMDP (atm)	Stokes no. STOKES
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Figure 6. PADRE data entry form: impactor data

SECTION 4

OPERATING INSTRUCTIONS

PADRE is an interactive, self-guided computer program, which novice as well as experienced computer users will find easy to run. The program resides at EPA/NCC on the UNIVAC system and may be accessed anywhere in the United States via the TYMNET® telecommunications network through a portable computer terminal. We strongly recommend that a permanent, printed copy of each session be filed as a regular part of the data documentation.

CONNECTION WITH THE COMPUTER--PADRE

Please check with the EPA Project Officer before attempting to run PADRE. He will answer any questions you may have about this document and will assign your unique UNIVAC Run-ID.

The first step in using PADRE is to establish communication with the UNIVAC computer at EPA/NCC, generally through the TYMNET® national telecommunications network. In metropolitan areas, a user can dial a local telephone number to gain access to the system. If you cannot find the TYMNET® number in the local telephone book, call the NCC Telecommunications office at (919) 541-4506 for instructions. When you have determined the correct number, dial it, wait for a tone, and place the phone receiver in the acoustic coupler for your terminal or make the appropriate connection between the phone and your terminal.

1. After a few seconds, you will be asked to enter your terminal type. Respond with "A."

   Figure 7 shows each line the computer will print on your terminal to prompt you and each line you should enter in response. It includes the output from a sample session, beginning with this signon procedure.

2. You will then be asked to log in.
   Enter "(Control H)UNIEPA1;NCC (Carriage Return = CR)."

   If you make a typographical error in this entry, TYMNET® will respond with ERROR, TYPE USER NAME:; you should then enter "UNIEPA1." Next, you will be prompted with PASSWORD:; now enter "NCC."
   After a brief pause, the computer will respond
   UNIV IS ONLINE.

```
Please type your terminal identifierA
-1447-001-
Please log in:UNIEPA1:NCC
P  S
UNIV IS ON LINE
@UNIVAC
xxxxxxxxxxxxxx   ENTER USERID/PASSWORD:
*DESTROY USERID/PASSWORD ENTRY
*UNIVAC 1100 OPERATING SYSTEM  LEV. 37R2C-30-148(RSI)*
   *** 6AX R2.5SA SCP PROCESSOR IS NOW AVAILABLE IN PRODUCTION FILE  ***
>@@TTY C,,\
-@@COMPLETE
>@@RUN 7:8TI,6302ZEADBS,EADS/EADSPPAD
DATE: 040783          TIME: 19:56:43
*** NEWS CURRENT AS OF 14:25:25 ON 03/08/83 ***

>@ADD WMY-RUN,PADRE
WMY-UID LOGGED TO SYSTEM LOG
READY
READY
READY
READY
READY
READY
READY
READY
READY
READY
**********************************************************************
                    * PADRE BULLETIN BOARD *

If you have trouble signing on,
          check the NCC System Status Recording at (919)541-2225 or -2227.
For immediate assistance, information, etc.,
          call BILL YEAGER 919/541-6287 or GENE TATSCH 919/541-6830.
**********************************************************************
READY
*** PARTICLE DATA REDUCTION AND ENTRY SYSTEM  RELEASE 1.4  04/07/83     15:40:23
DO YOU WANT AN INTRODUCTION TO PADRE?  ENTER Y OR N
>N

DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>Y

DO YOU WISH TO ENTER OR MODIFY ANY WEIGHTS? ENTER Y OR N
>N
DO YOU WISH TO ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>N

DO YOU WISH TO ENTER DATA FOR A RUN? ENTER Y OR N.
>N

DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>N

DO YOU WISH TO RETRIEVE RUN DATA?  ENTER Y OR N
>Y
ENTER YOUR SITE CODE, SITE (4 CHAR)
>COL
ENTER TEST DATE, IDATE (MMDDYY)
>11376
ENTER THE RUN NUMBER, IRUN
>2
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>N

DO YOU WISH TO PRINT FPEIS CODING FORMS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N
DO YOU WISH TO RETRIEVE A TEST?  ENTER Y OR N
>Y
ENTER SITE CODE, SITE (4 CHAR)
>COL
ENTER TEST DATE, IDATE, (MMDDYY)
>11376

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>N
 DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY?  ENTER Y OR N
>N

DO YOU WANT EXPANDED OUTPUT MAILED TO YOU?  ENTER Y OR N.
>N

DO YOU WISH TO RETRIEVE DATA FROM ANOTHER TEST?  ENTER Y OR N
>N

DO YOU WISH TO RETURN TO THE BEGINNING OF PADRE? ENTER Y OR N
>N

DO YOU HAVE ANY COMMENTS ON THIS PROGRAM OR ITS DOCUMENTATION? ENTER Y OR N
>N
EXIT FROM PADRE
ENTER @FIN TO EXIT FROM THE UNIVAC
>@FIN
```

Figure 7. PADRE logon and abbreviated session.

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3. Be sure your terminal is set to even parity and uppercase. The first time you do this, you may need to consult the operating manual that came with your terminal.
   Enter "UNIVAC (CR)."
   The computer will then prompt you with ENTER USERID/PASSWORD:.
   Enter the User-ID followed by a slash followed by the password for that User-ID (no spaces allowed).

   > You are now connected with the UNIVAC computer. When the computer is ready for you to enter data or a command, it will type a ">" symbol at the beginning of the line. If you enter something before the computer is ready, it will respond with *WAIT-LAST INPUT IGNORED*. When this happens, wait for the > and reenter the data or command.

4. Set the character delete key.
   Enter "@@TTY C,e (CR)" where "e" is the character you will use to "erase" an erroneous character.

   > The backspace key is commonly used for this function. If your terminal has no backspace key, use some key that you will not need when entering data or comments; e.g., the DEL key on a TI745 terminal. The "\" symbol has been used for the sample sessions. The computer will respond with @@COMPLETE.

5. Enter the RUN statement, specifying the housekeeping information to the computer exactly as shown in Figure 6. Note that your own Run-ID (assigned by the Project Officer) must be used rather than "43CET" because the latter serves as a number of functions, including output-routing. The computer will respond with the current date and time.
6. To activate the PADRE system, enter "@ADD WMY-RUN.PADRE (CR)." The computer will respond with several "READY's" and the bulletin board, and present you with the first of a series of options.

PADRE LOGICAL CONTROL

You can follow several paths through this program. For example, you may wish only to enter pre-weights for several sets of substrates, or you may wish either to update or to reduce previously entered data. You will be offered a series of options at decision points. At each decision point, you will be asked a question of the form "DO YOU WISH TO ...? ENTER Y OR N." You may choose either to accept the option (e.g., enter data for a new run) or to continue to the next decision point in the program, where you will be offered another option. Indicate your decision by entering Y or N; then depress the return key on the terminal. Any response other than Y or N will be rejected and you will again be prompted to enter Y or N.

The flowchart in Figure 8 is a guide to the options this program offers. There are three basic sections or loops. At the end of each section, you will have the option either to return to the beginning of that section or to proceed to the next section. After the last section, you will have the option to return to the beginning of the first section.

No "dead ends" exist in PADRE. If you take a wrong path, you can drop through to the bottom of the section, or of the program, and return to the beginning.

ESCAPE MECHANISM

If you wish to abort PADRE at any point, enter "@@X TIOC (CR)." After you have terminated the program, either normally or abnormally (using @@X), the UNIVAC operating system will prompt you for your next command with a ">" symbol in column 1. Enter "@FIN (CR)" to terminate the run and restore the status of all data files. You will then receive a summary of the computer resources you have used and EADS accounting information. (Note: should all measures fail, you can stop everything by hanging up the phone.) If you have reduced (analyzed) some data and indicated you want the expanded output in addition to that listed on the terminal, it will be printed at NCC and mailed to the address associated with your Run-ID ("21RTI" in the example).

DATA ENTRY AND REVIEW

Eventually, you will reach a point when you should enter observed data. You will be prompted with a brief description of and the name associated with the data item. The computer will then wait for you to enter the data. If you

```
--Introduction to the PArticulate Data REduction (PADRE) System--

An outline for logical flow of the program follows.
      Your comments and suggestions will be solicited as you exit from PADRE.

    "@ADD" PADRE
       |
   BULLETIN BOARD
       |
  INTRODUCTION TO PADRE?      <- You are here!!
       |
,----->----+
^   1. ENTER DATA?
^       +--->--YES-->-->-.
^      NO       ^   ^-->-->---->
^       |       ^       |
^       |       ^   ENTER/MODIFY WEIGHTS?     pre- & post-sampling weights
^       |       ^       |
^       |       ^   ENTER/MODIFY TEST DATA?     test keys & comments,
^       |       ^       |                          particle density
^       |       ^       |
^       |       ^   ENTER RUN DATA?       operating conditions, impactor id
^       |       ^       |
^       |       ^   ENTER MORE DATA?      repeat this section
^       |       ^-<-YES-<-+
^       +-<--<--<--NO-<-'
^       |
^   2. RETRIEVE A RUN?                        must provide RUN keys
^       +--->--YES-->-->-.                    (SITE, test DATE, RUN NUMBER)
^      NO       ^   ^-->-->---->
^       |       ^       |
^       |       ^   LIST DATA?            all data associated with RUN
^       |       ^       |
^       |       ^   MODIFY RUN DATA?      correct errors in RUN data
^       |       ^       |
^       |       ^   REDUCE RUN DATA?      calculate D50's, mass concentrations
^       |       ^       |
^       |       ^   DESIGNATE RUN FOR FPEIS?     print EADS forms 6 & 7a
^       |       ^       |
^       |       ^   RETRIEVE ANOTHER RUN       repeat this section
^       |       ^-<-YES-<-+
^       +-<--<--<-NO--<-'
^       |
^   3. RETRIEVE A TEST?                          must provide TEST keys
^       +--->--YES-->-->-.                         (SITE and DATE)
^      NO       ^   ^-->-->---->
^       |       ^       |
^       |       ^   REVIEW ALL RUNS?      Summary with one line per run
^       |       ^       |
^       |       ^   COMPARE RUNS?         Calculate summary statistics
^       |       ^       |
^       |       ^   CALCULATE PENETRATION/EFFICIENCY?
^       |       ^       |
^       |       ^   RETRIEVE ANOTHER TEST?      repeat this section
^       |       ^-<-YES-<-+
^       +--->--<--<-NO-<-'
^       |
^  RETURN TO BEGINNING OF PADRE?
^-<-YES-->
       |
    ENTER COMMENTS?
       |
   TERMINATE SESSION
```

You can follow several paths through this program. You will be offered a series of options at decision points. At each decision point you will be asked a question of the form "DO YOU WISH TO ...? ENTER Y OR N." You may choose either to accept the option (e.g. enter data for a new run) or to continue to the next decision point, where you will be offered another option. Indicate your decision by entering Y or N; then depress the return key on the terminal. Any response other than Y or N will be rejected and you will again be prompted to enter Y or N.

There are three basic sections or loops. At the end of each section you will have the option either to return to the beginning of that section or to proceed to the next section. After the last section, you will have the option to return to the beginning of the first section. There are no dead ends in PADRE. If you take a wrong path, you can always drop through to the bottom of the section, or of the program, and return to the beginning.

When you indicate that you are ready to terminate the program, you will be asked for comments about the program or its documentation. Please enter your comments while your experience with PADRE is still fresh in your mind.

NOTE: you can always abort & restart PADRE by:

1) @@x tie — This brings EVERYTHING to a screeching halt!
2) @fin — This closes all the data files properly.
3) @run 43xxx,63022.... — This restarts PADRE from the beginning.
4) @add PADRE
   etc.

Once you've done the "@@x tie," the data files are left in unpredictable states of assignment in the system, so steps 2 & 3 are necessary to reinitialize everything.

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Figure 8. PADRE introduction.

have completed copies of the data entry forms (see Figure 4-5) before logging on, you will be familiar with the required data and will be prepared to respond without searching records for each value. After all items have been entered, there will be a review of the data, listing both the names and values. You will then have an opportunity to mark which, if any, items you wish to change. If you do not want to change any of the data items named, depress the return key. If you make changes, there will be another review and opportunity to make further changes. When you have been through the entire list of variables and have made no changes, the system will proceed to the next decision point.

RECALLING PREVIOUSLY ENTERED DATA

PADRE manages all data storage and retrieval for the user, but certain user requirements are essentially matters of good housekeeping. These requirements are also for retrieving stored data.

- Substrate weights are assigned an ID by PADRE (see Figure B-1).
- Run data are saved by PADRE using multiple keys (see Figure B-4).

To retrieve stored data, the user must specify these keys exactly as originally specified or assigned. Whenever PADRE stores data, it prints a message with the keys that must be used to retrieve those data. Note that space for these keys is provided on the PADRE data entry forms (see Figure 4); you may wish to fill them in when the data are first entered.

If you want to recall data for an old (previously entered) run, you must specify the same site ID and test date you used when you originally entered the data, as well as the run number assigned by PADRE. Whenever a set of run data is stored, a line with these three key items and your contractor mnemonic ("RTI" in the example) is printed on the terminal (see sample session 4 in Appendix B). These keys should be recorded for future reference. You will be prompted for each of these items at the appropriate point in the session. If you want to recall data from an old test so you can modify the test data, you must specify the same site ID and test date as you did when the test data were entered. You can then change any of the test data; if you change any of the key items, the system will alter them for all runs in that test. Copies of the terminal output from several sample sessions are included in Appendix B.

SECTION 5

PROGRAM NARRATIVE

This section describes the major routines in the PADRE system on a conceptual level and is intended to help the reader understand the context and meaning of messages to the user. By reading this section, the user should understand the purpose of each routine and how to negotiate it; i.e., the consequences of each decision point, data that must be entered, and output generated.

The narrative is not intended to explain the source code. Names are mentioned only for variables that the user may wish to update or that are referenced several times when calculations are discussed.

MAIN

The main routine is called PADRE. This routine assigns the files that will be used by the run, presents the user with the major decision points, and calls appropriate subroutines to perform the various functions of the PADRE system.

The main routine contains three basic sections. Section 1 is for data entry and for modification of weight and test data. Section 2 is for functions that require retrieval of previously entered data for one run. These include listing all data associated with a run, modifying run data, reducing run data, and designating a run for inclusion in FPEIS. Section 3 is for functions that require retrieval of several runs. These include reviewing all runs in a test, comparing several runs, and calculating penetration vs. particle size. At the end of each section, the user has the option to return to the beginning of that section or to proceed to the next section.

The first option is to print an introduction to PADRE at the terminal, including a system flowchart (see Figure 8).

Section 1

The user is asked whether he wishes to enter data or to modify weight or test data. If the response is affirmative, section 1 is entered; otherwise, control passes to section 2.

The first option in section 1 is to enter or modify weights. If the user selects this option, he is prompted to enter the substrate's ID assigned by PADRE when the pre-weights were first entered or to enter 0 (zero) if these weights have not been previously entered. The WEIGHT routine is then called.

The second option in section 1 is to enter or update test data. If the user selects this option, he is prompted to enter the site code and the test date. The TSTCND routine is then called.

The third option in section 1 is to enter data for a new run. If the user selects this option, the NEWRUN routine is called, followed immediately by the PUTRUN routine to store the data.

The last option in section 1 is to enter more data. If the user selects this option, control returns to the begining of section 1; otherwise, control passes to section 2.

MAIN (continued)

Section 2

The user is asked whether he wishes to retrieve run data. If the response is affirmative, section 2 is entered. The user is prompted to enter the keys (site code, test date, and run number) for the existing run he wishes to retrieve. The GETRUN routine is called to read the specified record from the trial data file. If the record is not found, the user is prompted to enter different keys. If the user does not change any of the keys, he is given an opportunity to return to the top of the program and enter more data.

When the data for the specified run have been retrieved, the user is given the option to list them on the terminal. If this option is selected, the RUNLST routine is called.

The next option in section 2 is to modify any of the run data. If the user selects this option, the RUNCND, PUTRUN, and RUNLST routines are called.

At this point, the user is asked whether he wishes to return to the beginning of section 2 and retrieve data from another run for listing or modification. If the user elects this option, he will be prompted to enter new run keys.

If data for the run have passed PADRE's internal checks, the user then has the option to reduce the data. If the user selects this option, the REDUCE routine is called. When control returns from this routine, the user is given the option to route the expanded output, which is always generated by REDUCE, to a line printer at NCC. If the user selects this option, the expanded output file is printed and mailed to him.

If data for the run have passed PADRE's internal checks, the next option is to select the run for inclusion in FPEIS. If the user selects this option, the FORMS routine is called. This routine saves the observable data in the expanded output file in the format of EADS data forms 6 and 7a. When control returns from the FORMS routine, the expanded output file is printed and mailed to the user.

The last option in section 2 is to retrieve data for another run. If the response is affirmative, control returns to the beginning of section 2; otherwise, control passes to section 3.

MAIN (continued)

Section 3

The user is asked whether he wishes to retrieve data for several runs in a test. If the response is affirmative, section 3 is entered; otherwise, control passes to the end of the program.

The first option in section 3 is to review all runs in a test. If the user selects this option, he is prompted to enter the site code and the test date. The REVIEW routine is then called.

The second option in section 3 is to compare several runs in a test. If the user selects this option and if test keys previously have been specified for review, the user is asked whether he wishes to compare runs in the previously specified test. Otherwise, the user is prompted to enter the test keys. The COMPAR routine is then called.

The third option in block 3 is to calculate penetration/efficiency as a function of particle size. If the user selects this option and if test keys have been specified previously, the user is asked whether he wishes to use the previously specified test. Otherwise, the user will be prompted to enter the test keys. Then the PENEFF routine is called.

The last option in block 3 is to return to retrieve data from another test. If the response is affirmative, control returns to the beginning of block 3; otherwise, the user is asked whether he wishes to return to the begining of PADRE; i.e., the beginning of block 1.

If the user does not wish to repeat the program, he is asked for comments about the program or its documentation. If any comments are made, the PADCOM routine is called. Then the program terminates.

CHECK

The CHECK routine performs various tests on the data and warns the user of inconsistent or suspicious values. In addition, invalid values of certain variables, which would cause abnormal termination of the program during data reduction, are noted as errors. Data reduction is prohibited for runs containing such data; the user must correct the invalid values(s) before the data can be reduced. Appropriate messages are printed on both the terminal and the expanded output. Warning messages are preceded by three asterisks; error messages, by five. Table 1 on page 10 contains a complete list of error and warning messages and the conditions that generate them.

COMPAR

This routine is called to compare several runs. Data for each run are reduced and interpolated to standard diameters. For each diameter, statistics on interpolated values are calculated.

First, the user is prompted to select the definition of diameter (Stokes', TGLD, or Mercer's) to calculate the effective cut points (D_{50}'s). Then, the user is prompted to select the variable (e.g., differential mass concentration, cumulative mass concentration, or cumulative percent mass) for which statistics will be calculated. Next, the user must enter the confidence interval (as a multiple of the standard deviation) to be used to identify outliers. This should be a physically reasonable number (e.g., 2, 2.5, or 3).

The user must specify the runs to be compared, either by entering their run numbers or by entering a run type (inlet or outlet). Note that inlet runs may not be compared with outlet runs. If the user specifies the run numbers, the run type of the first run number in the list will be saved; subsequent runs in the list of different type will be omitted from the comparison, with the message

*** WRONG TYPE RUN

The run number is set to one. The GETRUN routine is called to read the data. If the run is not found, control passes to the section to calculate statistics. If the run is found but data are incomplete, the message

*** DATA FOR RUN ccc ssss mmddyy nn IS INCOMPLETE

is printed, the run number is incremented, and GETRUN is called to read data for the next run in the test.

If the run is found and the data are complete but the run type does not match, the run number is incremented and GETRUN is called. Otherwise, the REDUCE routine is called to calculate cumulative and differential mass concentrations and to interpolate them to standard diameters. The message

REDUCE DATA FOR RUN nn

is printed. The run keys, run date, start time, run duration, and total mass concentration are saved in storage vectors. The interpolated differential and cumulative mass concentations are saved in storage arrays. The cumulative

mass concentration is converted to cumulative percent mass and saved in a storage array. The number of runs is incremented. If the number of runs exceeds 20, the message

*** MORE THAN 20 RUNS SPECIFIED, ONLY 20 WILL BE USED

is printed and control passes to the section to calculate statistics. Otherwise, the run number is incremented and GETRUN is called to read the data for the next run in the test.

When data from all specified runs have been saved in the storage arrays, statistics can be calculated. The average value of each variable (i.e., differential mass concentration, cumulative mass concentration, and cumulative percent mass) at each standard diameter is calculated. For the selected variable, standard deviation, minimum value, and maximum value also are calculated. Individual values that differ from the average by more than the number of standard deviations specified by the user are flagged as outliers. Runs that contain outliers are then flagged.

Next, results of the comparison are printed. The run keys of all runs used are printed. Runs containing outliers are indicated by an asterisk after the run number. If this is the first pass through the comparison, the run date, start time, total mass, and interpolated values of the selected variable for each run are printed. Outliers are marked by an asterisk after the value.

Summary statistics are printed for each standard diameter. These include standard diameter; averages for the three variables; and standard deviation, minimum value, and maximum value for the selected variable. However, only statistics to which all runs contributed are printed. If any run had a minimum effective cut point larger than the standard diameter, statistics for that diameter are suppressed.

The user is asked whether he wishes to plot the cumulative percent mass. If so, a scatter plot of log (standard diameter) vs. cumulative percent mass for all runs in the comparison is printed on the user's terminal, which allows the user to visualize the relationships among the runs. Each point is represented by a '1.' If more than one point falls within the same element of the 65-column by 50-line grid, these points are represented by the numeral corresponding to the number of points in that element.

COMPAR (continued)

The user then has the option to repeat the comparison, excluding some runs. If the user selects this option and if there were any outliers, he is given the option to exclude all runs with outliers. Otherwise, the user must enter a list of run numbers to be excluded. Control then passes to the section to calculate statistics.

If the user does not wish to exclude some runs and repeat the comparison, control returns to the main routine.

Sample session 11 in Appendix B illustrates this routine.

FORMS

The FORMS routine writes observed, validated data designated by the user to the expanded output file in the format of EADS/FPEIS forms 6 and 7a for printing at NCC.

First, data are converted to the standard metric units required by EADS/FPEIS. Then total sample volume is calculated.

Run data are printed through formats appropriate for EADS form 6.

Weight data are printed through formats appropriate for EADS form 7a.

Control returns to the main routine.

FNDSLT

This routine finds an available record (slot) in the trial data file for a new run or an old run with new keys.

A trial index is formed using the same scheme described for the GETRUN routine. Only the portion of the record containing keys is read. If the record is empty or marked deleted, control returns to the calling routine. If the record contains keys that do not match the specified keys, the trial index is incremented and the next record is read.

If the record contains keys that match the specified keys, the message

*** ANOTHER RUN WITH THIS ID ALREADY EXISTS

is printed and control returns to the calling routine.

If a read error occurs, the message

*** ERROR READING TRIAL DATA FILE. I/O STATUS CODE = nnnn FOR RECORD nnn

is printed and control returns to the calling routine.

If no slot is available (i.e., the trial data file is full), the message

*** TRIAL DATA FILE IS FULL

is printed and control returns to the calling routine. The user should notify the PADRE support staff of this occurrence.

GETRUN

This routine reads a record from the trial data file.

First, a trial index is constructed. Then, the trial data file is read and the record is examined. If the record is empty, control returns to the calling routine. If the record is marked deleted or contains keys that do not match the desired keys, the trial index is incremented and the next record is read.

If all keys in the record match the specified keys, and if GETRUN was called from TSTCND or NEWRUN, control returns to the calling routine.

Otherwise, the NETWT routine is called to read the corresponding weight record and to calculate the net weights. Then, the CHECK routine is called to test the run data. If all values pass their respective tests, the logical argument COMPLT is set to true.

Control returns to the calling routine.

IMPDSC

The IMPDSC routine reads the impactor description file and returns with calibration constants for the specified impactor. The maximum number of stages currently allowed by PADRE is 20.

The impactor description file is searched sequentially until a record that matches the specified impactor type, impactor model, and plate set ID is found. The logical argument FOUND is set to true and the calibration information for each stage is then read.

If no matching impactor record is found, the logical argument FOUND is set to false.

Control returns to the calling routine.

INTERP

This routine interpolates the cumulative mass concentration (mg/DNCM) calculated by REDUCE to standard diameters. Input points are DMAX, the measured cut points, and the corresponding cumulative mass concentrations. The desired D_{50}'s (standard diameters) are also input. Both cumulative and differential mass concentrations at the desired diameters are calculated.

First, the output values are initialized to zero. Next, the input is tested to ensure that it is appropriate for interpolation.

If there are less than four measured points, the message

*** TOO FEW KNOWN POINTS TO INTERPOLATE, NK= no. points

is printed and control returns to the calling routine (REDUCE).

If the smallest measured D_{50} is not positive, the message

*** KNOWN ABCISSA VALUES MUST BE POSITIVE

is printed and control returns to the calling routine.

If the smallest measured cumulative mass is negative, the message

*** KNOWN ORDINATE VALUES MUST BE NONNEGATIVE

is printed and control returns to the calling routine.

If the measured D_{50}'s are not monotonically increasing, the message

*** KNOWN ABCISSA VALUES MUST BE MONOTONIC

is printed and control returns to the calling routine.

If the cumulative masses are not monotonically increasing, the message

*** KNOWN ORDINATE VALUES MUST BE MONOTONIC

is printed and control returns to the calling routine.

If the first desired D_{50} is not positive, the message

*** DESIRED ABCISSA VALUES MUST BE POSITIVE

is printed and control returns to the calling routine.

If the desired D_{50}'s are not monotonically increasing, the message

*** DESIRED ABCISSA VALUES MUST BE MONOTONIC

is printed and control returns to the calling routine.

When input values have passed the above tests, DMAX and the measured cut points are transformed to logarithms.

Each desired diameter is expanded to three values--D/1.1, D, and 1.1*D--which are transformed to logarithms. Cumulative mass concentration is interpolated at each of the expanded diameters by using either a parabola or an osculating polynomial. Parabolic interpolation is used for diameters

INTERP (continued)

within the interval of the measured cut points.

The Lagrangian form[7] of the interpolating polynomial is used for parabolic interpolation

$$YE = YK(I)\frac{[XE-SK(I+1)]*[XE-XK(I+2)]}{[XK(I)-XK(I+1)]*[XK(I)-XK(I+2)]} + YK(I+1)\frac{[XE-XK(I+2)]*[XE-XK(I)]}{[XK(I+1)-XK(I+2)]*[XK(I+1)-XK(I)]} + YK(I+2)\frac{[XE-XK(I)]*[XE-XK(I+1)]}{[XK(I+2)-XK(I)]*[XK(I+2)-XK(I+1)]}$$

where

XK(I) is a measured cut point

YK(I) is the measured cumulative mass < XK(I)

XE is an expanded diameter XK(I) < XE < XK(I+1)

YE is the interpolated cumulative mass < XE .

For desired diameters between DMAX and the largest measured cut point, the osculating polynomial[8] is used to interpolate cumulative mass concentration. This third-order polynomial passes through both points, has zero slope at DMAX, and matches the slope of the cumulative mass distribution between the first two (largest) measured cut points. The OSCFIT routine is called to determine the coefficients of the polynomial.

When the cumulative mass distribution has been interpolated at each of the expanded diameters, the differential mass concentration at each standard diameter may be calculated

$$YD(J) = YE(K)$$

$$YDP(J) = \frac{YE(K+1) - YE(K-1)}{XE(K+1) - XE(K-1)}$$

where

YD(J) is the cumulative mass distribution at the desired diamter D(J)

YDP(J) is the differential mass distribution at the desired diamter D(J).

Control then returns to the calling routine (REDUCE).

NETWT

The NETWT routine reads a record from the weight file and calculates the net weights.

The NETWT routine first checks that the index of the weight record, IDSUBS, is valid (positive and $\leq$ the maximum index for the weight file). If IDSUBS is valid, that record is read from the weight file. When the record has been read, the net weights are calculated. If any net weights are $\leq$ zero, the message

*** WEIGHT nn SHOULD BE POSITIVE, NOT nnn.nnn

is printed. When all net weights have been calculated, control returns to the calling routine.

If the specified weight record was entered by another contractor or by someone with a different User-ID, the message

***** WEIGHT RECORD nnn BELONGS TO ANOTHER CONTRACTOR/USER

is printed and control returns to the calling routine.

If the specified weight record is associated with a different run than the current run, the message

***** WEIGHT RECORD nnn BELONGS TO RUN nn AT ssss ON mmddyy

is printed and control returns to the calling routine.

If the record is deleted, the message

*** WEIGHT RECORD nnn IS DELETED

is printed and control returns to the calling routine.

If IDSUBS is not valid, the message

*** INVALID WEIGHTS ID=nnn NET WEIGHTS CANNOT BE CALCULATED

is printed and control returns to the calling routine.

If there is a read error, the message

*** UNABLE TO READ RECORD nnn FROM WEIGHT FILE IN SUBROUTINE NETWT

is printed and control returns to the calling routine.

NEWRUN

The NEWRUN routine is called to enter run data for a new run.

If the test keys--SITE and IDATE--have not yet been specified, the user is prompted to enter them. Then a run number, IRUN, is assigned by PADRE to the new run. The run number is set to one and the GETRUN routine is called to determine whether run one has been entered previously. If it has, the test data will be propagated to the new run. If run one contains only test data (e.g., run type is blank and duration is zero), the new run will be run number one. Otherwise, IRUN is incremented and the FNDSLT routine is called. This process continues until no record for the run number is found. Then, a message specifying the run number is printed:

```
THE COMPLETE ID FOR THIS RUN IS CNTRTR=ccc SITE=ssss IDATE=mmddyy IRUN=nn
*** RECORD THESE VALUES IN YOUR NOTEBOOK
```

Next, the user is prompted to enter values for each run condition. Each prompt briefly describes the variable, the variable name, and units, if any; e.g.,

```
ENTER DURATION OF RUN, DUR, IN MINUTES
```

When all values have been entered, the NETWT routine is called to read the record specified by IDSUBS from the weight file and to calculate the net weights. The CHECK routine is then called to perform PADRE's internal tests of the values. If all values pass these tests, the logical argument COMPLT is set to true; otherwise, it is set to false.

Control returns to the main routine.

Sample session 3 in Appendix B illustrates this routine.

OSCFIT

This routine determines coefficients of a third-order polynomial between two points. In addition to coordinates of the two points, the slope of the function at each point is specified. The function is required to be monotonic on the interval. Coefficients of the polynomial are output. This routine was taken from the CIDRS system and is discussed in more detail in Reference 8.

The first-order osculating polynomial P(X) can be described by Hermite's formula[9]:

$$
\begin{aligned}
P(X) &= U_1(X)Y(X_1) + U_2(X)Y(X_2) + V_1(X)S(X_1) + V_2(X)S(X_2) \\
&= [1 - 2(X-X_1)/(X_1-X_2)][(X-X_2)/(X_1-X_2)]^2\, Y(X_1) \\
&+ [1 - 2(X-X_2)/(X_2-X_1)][(X-X_1)/(X_2-X_1)]^2\, Y(X_2) \\
&+ [(X-X_1)(X-X_2)^2/(X_1-X_2)^2]\, S(X_1) \\
&+ [(X-X_2)(X-X_1)^2/(X_2-X_1)^2]\, S(X_2) \\
&= a_1 + a_2X + a_3X^2 + a_4X^3
\end{aligned}
$$

where

X_1 is the largest measured cut point (cyclone or first stage)

$Y(X_1)$ is the measured cumulative mass < X_1

$S(X_1)$ is the slope of the cumulative mass distribution between the first two (largest) measured cut points

X_2 is the observed maximum particle diameter (DMAX)

$Y(X_2)$ is the total mass concentration

$S(X_2)$ is the slope of the cumulative mass distribution at X_2 (i.e., zero)

X is the desired diameter in the interval.

Multiplying the terms in brackets and collecting terms by powers of X allows one to express the function as a third-order polynomial with four coefficients.

Sometimes, especially when the slope at X_1 is large, the osculating polynomial may have a local maximum greater than $Y(X_2)$ and a local minimum at X_2. This nonphysical behavior can be removed by redefining X_2 to be less than the observed maximum particle diameter. Coefficients of the polynomial are then recalculated until the zero slope point is found. The zero slope point is the value of X_2 where the osculating polynomial reaches and maintains zero slope. This value is also returned to the calling routine.

PADCOM

This routine allows the user to enter comments about the PADRE system for periodic review by the support staff. Problems and suggestions may be recorded before the PADRE session is ended.

The routine reads the first record in the comments file. This record should contain the index, LAST, of the last record written to the comments file. This index is incremented and a header record containing contractor code, User-ID, date, and time at the beginning of the session is added to the comments file.

Next, the routine reads a line (< 133 characters) from the terminal. If the first eight characters of the line are blanks or "RETURN," the message

THANK YOU FOR YOUR COMMENTS

is printed. The first record in the file is rewritten with the new value of LAST. Control returns to the calling routine.

Otherwise, the contents of the line are written to the next record in the comments file. Another line is read from the terminal and examined.

PENEFF

This routine is called to calculate the penetration factor and efficiency of control at each standard diameter.

First, the user is prompted to specify the definition of aerodynamic diameter. Next, he is prompted to enter a list of runs in the test to be used in the calculation; if 0 (zero) is entered, all runs in the test are used.

For each run specified, the GETRUN routine is called to read the data. If the run is not found, the message

*** NO RECORD FOR RUN ccc ssss mmddyy nn

is printed and GETRUN is called to read the data for the next run specified.

If the run is found but the data are incomplete, the message

*** DATA FOR RUN ccc ssss mmddyy nn IS INCOMPLETE AND CANNOT BE USED

is printed and GETRUN is called to read the data for the next run specified.

If the run is found and the data are complete, the REDUCE routine is called to calculate the differential mass concentration at standard diameters. These distributions are saved in storage arrays. Concentrations from inlet runs are saved separately from concentrations from outlet runs.

When data from all runs have been saved, the average and standard deviations for all inlet runs at each standard diameter are calculated. The average and standard deviations for all outlet runs at each standard diameter also are calculated. At each diameter

$$\text{Penetration} = \frac{\text{(average differential mass concentration for outlet runs)}}{\text{(average differential mass concentration for inlet runs)}}$$

The error in this penetration is

$$\text{Error} = \text{Penetration}\left[\left(\frac{\text{std. dev. for outlet runs}}{\text{avg. for outlet runs}}\right)^2+\left(\frac{\text{std. dev. for inlet runs}}{\text{avg. for inlet runs}}\right)^2\right]^{1/2}$$

The efficiency is simply

Efficiency = 100 (1-Penetration)

The standard diameter and corresponding penetration, error in the penetration, and efficiency are printed.

Sample session 12 in Appendix B illustrates this routine.

PUTRUN

The PUTRUN routine writes a record in the trial data file.

First, a system routine is called to determine the current date. This date is included in the record in the trial data file. When the data have been stored, the message

DATA FOR RUN n BY ccc AT ssss ON mmddyy HAS BEEN SAVED IN THE TRIAL DATA FILE

is written. Otherwise, the message

***** UNABLE TO WRITE TRIAL DATA RECORD nnn I/O STATUS CODE = nnnn

is printed.

Control returns to the calling routine.

REDUCE

The REDUCE routine calculates and prints the effective cut points (D_{50}'s) and mass concentrations. This routine is based on the CIDRS program MPROG.[1]

First, the test comments and run comments are written to the expanded output file. Next, the values of PADRE variables are moved into the corresponding CIDRS variables; e.g.,

ARHO = RHO

DMAX1 = DMAX

CYC3 = CYCL

If the dry components of the stack gas do not equal 100 percent, each component is normalized so the run will be 100 percent. The message

*** GAS COMPONENTS NORMALIZED SO THAT SUM = 100%, NOT nn.n

is printed. The wet gas composition is calculated based on the formula wet fraction = (1.0 - %H_2O/100)(dry %/100).

The molecular weight of the wet gas is calculated based on the formula

AMOLWT = 44.10 (CO_2 fraction) + 28.01 (CO fraction) + 28.02 (N_2 fraction) + 32.00 (O_2 fraction) + 18.02 (H_2O fraction)

The impactor temperature is converted to degrees Rankine and Celsius and to absolute temperature in Kelvin. The stack temperature is converted to degrees Celsius and Kelvin.

The impactor flow rate is converted to actual cubic feet per minute by using the relationship

Q = FLOW (absolute impactor temp/absolute stack temp)

The percent of isokinetic flow is calculated. The first of two terms represents the volume of liquid (H_2O) collected in the impingers, and the second represents the volume of gas sampled.

ANOZZ = cross-sectional area of nozzle $3.14159*(DNOZZ/2)^2$

$$\frac{PCISOK}{100.0} = \left(\frac{\text{absolute stack temp}}{60*VSTACK*ANOZZ}\right)\left(\frac{0.2195*VOLH2O}{DUR*PSTACK} + \frac{FLOW}{\text{(absolute impactor temp)}}\right)$$

The VIS routine is called to calculate the stack gas viscosity, ETA.

If a nozzle were used and if its cut point were not specified by the user, the cut point would be calculated as if the nozzle were a single jet impactor stage.

REDUCE (continued)

$$CUTNOZ = 0.35*\left(\frac{18*ETA*DNOZZ*ANOZZ}{RHO*FLOW}\right)^{1/2}$$

The IMPDSC routine is called to get the impactor calibration constants from the impactor description file. These constants are written to the expanded output file. The values are moved into CIDRS variables. If the calibration information is not found, the message

*** NO CALIBRATION INFORMATION AVAILABLE FOR IMPACTOR TYPE = iiiiii PLATE SET ID = ppp

is printed and control returns to the calling routine.

The pressure drop across the impactor is calculated based on the formula

DPIMP = (impactor scaling factor)*(Q^2)*(PSTACK/TIMP)*(AMOLWT)

For each stage, the mean free path, L(I), local pressure, PS(I), jet velocity, VJETS(I), and Reynolds number are calculated.

FACTOR = SQRT[(BK*PI*TKI*6.023 x 10^{23})/(8*AMOLWT)]

where

BK = 1.38 x 10^{-16} Boltzman's constant (erg/K), and

PI= 3.14159

L(I)= 2*FACTOR*ETA/[3.3865 x 10^4*PS(I)]

PS(I) = PSTACK - CUMDP(I) * DPIMP

VJETS(I)= (flow rate/area)*(PSTACK/PS(I))

The total volume of gas sampled (actual cubic feet) is simply

VACF = (impactor flow rate)*(sampling duration)

This total is converted to dry normal conditions

VDNCF = (VACF)*(1.0 - % H_2O/100)*(PSTACK) * (294/absolute stack temp)

These are then converted to cubic meters

VACM = 0.028317*VACF

VDNCM = 0.028317*VDNCF

The mass concentration on each stage is simply

AMASS(I)/VDNCM

Total mass concentration is calculated in four units: grains/acf, grains/dncf, mg/acm, and mg/dncm.

Values independent of the definition of aerodynamic diameter (i.e., flow rate, temperatures, sampling, duration, pressure drop across impactor, stack

pressure, stack gas composition, and total mass concentration) are written to the expanded output file.

Next, the cumulative mass < D_{50} for each stage is calculated. If a backup filter were used, the filter mass would be assumed to be due to particles smaller than the cut point of the last stage unless the filter collected large particles. If FLARGE is YES, the filter mass entered by the user is ignored. The message

*** FILTER CONTAMINATED. ASSUME MASS SHOULD HAVE BEEN HALF THAT OF LAST STAGE
CUM. MASS NORMALIZED TO TOTAL MASS

is printed. The total mass used in the cumulative percent mass calculations is reduced by the measured filter mass and incremented by half the mass on the last (smallest D_{50}) stage.

If a backup filter was not used, the message

*** FILTER MISSING. ASSUME MASS WOULD HAVE BEEN HALF THAT OF LAST STAGE
CUM. MASS NORMALIZED TO TOTAL MASS

is printed. The total mass is incremented by half the mass on the last stage. Calculation begins with the last stage and proceeds to the first stage or cyclone. The sum of the masses of the previous stages is divided by the total volume sampled to determine the concentration in mg/acf, mg/dncf, mg/acm, and mg/dncm. The cumulative percent mass for each stage also is calculated.

The rest of the routine is a loop for the calculations that depend on the definition of aerodynamic diameter. If the REDUCE routine was called by MASTER, all three definitions will be used and the loop will be executed three times. If REDUCE was called from COMPAR or PENEFF, the loop will be executed only once. The loop index is IPASS. A value of one corresponds to the classical or Stokes' definition, a value of two correponds to the aerodynamic or TGLD definition,[8] and a value of three corresponds to the aerodynamic impaction or Mercer's definition.[9]

If the TGLD or Mercer's definition is used, the maximum particle diameter and the cyclone cut point are multiplied by the square root of the assumed particle density. A particle density of 1.0 is used to calculate the effective cut points and the differential number concentration. The maximum particle diameter and the cyclone cut point are adjusted by a factor of the square root of the assumed particle density, RHO.

REDUCE (continued)

ARHO = 1.0

DMAX1 = DMAX*SQRT(RHO)

CYC3 = CYCL*SQRT(RHO)

The definition of diameter used is written to the expanded output file. The effective cut point (D_{50}) of each stage is calculated through a method developed by Ranz and Wong.[10] For Stokes' and the TGLD definition of aerodynamic diameter, the Cunningham slip correction factor is calculated. As a first approximation,

SLIP= 1.0

D501= SQRT[(18*STOKES*ETA*DJETS(I)*PS(I))/(ARHO*VJETS(I)*PSTACK)]

D50(I)= D501

For Stokes' and the TGLD definition of diameter, the calculation is iterative.

SLIP= 1+[2*L(I)/D50(I)]*[1.23+0.41*EXP(-0.44*D50(I)/L(I))]

D50(I)= D501/SQRT(SLIP)

SLIP and D50(I) are recalculated until the value of D50(I) changes by less than 0.1 percent.

D50's, net weights, mass concentrations in various units, and cumulative percent mass are written to the expanded output file.

Next, the geometric mean diameter, the differential mass concentration [$dM/d(\log D_{50})$], and the differential number concentration [$dN/d(\log D_{50})$] are calculated. The geometric mean diameter of the first stage (or cyclone) is the square root of the product of the maximum particle diameter and the D_{50} of the first stage (or cyclone). The differential mass concentration is the mass concentration for first stage (or cyclone) divided by the difference of the common logs of the maximum particle diameter and the D_{50} of the first stage (or cyclone). The differential number concentration is simply the differential mass concentration divided by the mass of an average particle, which is taken to be

mass = ARHO*(4/3)*PI*(GEOPMD/2)^3 = PI*ARHO*GEOMD^3/6

where

GEOMD = geometric mean diameter.

PI = 3.14159

REDUCE (continued)

Note that ARHO is in grams per cubic centimeters while GEOMD is in microns, so

GEOMD(1) = SQRT(DMAX1*D_{50}(1))

DIFF (1) = ALOG10(DMAX1) - ALOG10(D_{50}(1))

DMDLD (1) = AMASS(1)/(VDNCM*DIFF(1))

FMASS = 6 x 10^9/(3.14159*ARHO)

DNDLD (1) = FMASS*DMDLD(1)/GEOMD(1)**3

For subsequent stages, the geometric mean diameter is the square root of the product of the D_{50} for that stage times the D_{50} for the previous stage. The differential mass concentration is the mass concentration for that stage divided by the difference in the logs of the D_{50}'s for that stage and the previous stage. The differential number distribution is the factor defined above times the differential mass distribution divided by the cube of the geometric mean diameter.

GEOMD (I) = SQRT(D_{50}(I-1)*D_{50}(I)

DIFF (I) = ALOG10(D_{50}(I-1))-ALOG10(D_{50}(I))

DMDLD (I) = AMASS(I)/(VDNCM*DIFF(I))

DNDLD (I) = FMASS*DMDLD(I)/GEOMD(I)**3

Calculations involving the backup filter assume an effective cut point equal to half the D_{50} for the last stage. The geometric mean diameters and the differential concentrations are written to the expanded output file.

If the REDUCE routine was called from MASTER, the user is asked whether he wants to see results on the terminal. If the user responds affirmatively, the run comments, total mass concentration, maximum particle diameter, net weights, mass concentrations (mg/dncm), cumulative mass concentrations (mg/dncm), D_{50}'s, geometric mean diameters, dM/d(log D_{50}), and dN/d(log D_{50}) are printed on the terminal.

Before interpolation to standard diameters, the data must be screened to protect against instabilities in the interpolation procedure. The D_{50}'s and cumulative mass distribution (mg/dncm) are the input for the interpolation procedure. The maximum particle diameter and total mass concentration also are treated as a data pair. If the D_{50}'s of two stages (or the cyclone and

stage one) are within 40 percent of each other, the downstream point is omitted (see sample session 7 in Appendix B). The warning

*** CUT POINTS FOR STAGES nn mm ARE SIMILAR OR INVERTED
MEASURED DATA FOR STAGE mm WITH D50= dd.dd OMITTED FROM INTERPOLATION

is printed. The INTERP routine is called to perform the interpolation.

If the interpolated cumulative mass is not monotonic, the message

*** INTERPOLATED CUMULATIVE MASS DECREASES BETWEEN nn.n AND nn.n MICRONS

is printed.

If the REDUCE routine were called from MASTER and if the INTERP routine set its return code to zero, the standard points and the interpolated values of the cumulative and of the differential mass distributions at those points are written to the expanded output file. If the user requested abbreviated output at the terminal, these values are also printed on the terminal.

If the user specified any non-standard diameters for interpolated mass concentrations, the cumulative and differential mass concentrations are interpolated at those diameters. These values are then printed.

Next the user is asked if he wishes to plot the cumulative percent mass. If the response is affirmative, a plot of log (D_{50}) vs. cumulative percent mass is printed on the user's terminal. Interpolated points (output from INTERP) are represented by the character "1;" measured points (input to INTERP) are represented by the character "2;" points which fall within the same element of the 65 column by 50 line grid are represented by the character "3."

If this is the first or third definition of diameter, the message

NORMAL (ENGINEERING STANDARD) CONDITIONS ARE 21 DEG C AND 760 MM HG.

is written to the expanded output file and a new page command for the line printer is generated.

If the calculations are to be repeated for another definition of diameter, control returns to the top of the loop; otherwise, control returns to the calling routine.

REVIEW

This routine is called to review all runs in a test.

The run number is initialized to one. GETRUN is called to read the data. For the first run in the test, the test keys, the assumed particle density, and the test comments are printed. For each run the run number, run type, run date, start time, run duration, substrate's ID, impactor type, impactor plate set ID, and the first 40 characters of the run comments are printed. The run number is incremented and GETRUN is called to read data for the next run. If a run number is not found, the run number is incremented and GETRUN is called again; thus, the program will continue past a deleted run. When two successive run numbers are not found, control returns to the main routine.

Sample session 10 in Appendix B illustrates this routine.

RUNCND

The RUNCND routine updates run data. Because the data entry routine NEWRUN prompts the user with the variable name as well as with a brief description and because the RUNLST routine displays the variable name as well as the brief description, the user should be familiar with the variable names by this point. If not, he may refer to a data entry form (see Figures 4 and 5) or a printed copy of a previous session.

The run data are divided into five groups. The names of all the variables in a group are printed on one line. The user is prompted to
ENTER A MARK UNDER THE VARIABLE(S) YOU WISH TO MODIFY OR RETURN

If the user enters a mark in any column under a variable name, he is then prompted to enter a new value for that variable; e.g.,
ENTER NEW VALUE FOR DUR

After all marked variables have been modified, the next group of variable names is printed and updated. This process continues until all five groups have been presented and no modifications have been made. For example, suppose the user updates the impactor plate set ID, which is in group three. The RUNCND routine will present group 1, group 2, group 3; will update IPLATE; then will present group 4, group 5, group 1, group 2, group 3.

When no further modifications are indicated, the CHECK routine is called to test the data. If any values fail these tests, the user is given an opportunity to repeat the update process. If he refuses this opportunity or if CHECK finds no problems, the COMPLT variable is set, based on the value of VALID (1), and control returns to the main routine.

Sample session 5 in Appendix B illustrates this routine.

RUNLST

This routine displays all stored information about a specified run--weight data, test data, run data, and impactor description--at the terminal for review by the PADRE user.

A header with the four run keys begins the listing, followed by test comments and assumed particle density. Each item in the listing includes the name, brief description, and value of the variable.

The run data are listed after the test data. If EPA Method 5 was used to determine flow rate, all Method 5 variables are listed. Otherwise, only the flow rate and method of determination appear.

The IMPDSC routine is called to get the impactor description and calibration information, which is listed after the run data. The net weights also are displayed.

If the user requested that mass concentrations be interpolated at nonstandard diameters, these diameters are listed.

All data the user has entered thus are available for review and validation. The impactor calibration information is included so the user can verify that the correct impactor was used. The user also may wish to check the D_{50}'s and mass concentrations calculated by PADRE.

Sample session 4 in Appendix B illustrates this routine.

TSTCND

The TSTCND routine is called to enter or update test data, which are saved in the trial data file.

First, the routine asks the user whether he wishes to enter data for a new test. If the answer is affirmative, he is prompted to enter the test comments and the assumed particle density. Otherwise, the run number is set to one and the GETRUN routine is called to retrieve the previously entered values. The site code and test date are saved for subsequent use.

Next, the test data--site code, test date, test comments, and particle density are printed for review, followed by the variable names on one line. The user is prompted to mark any variables he wants to change by entering a character under them on the next line. If any test data are changed, there is another review and another opportunity for additional changes.

When no more changes are desired, the test data are ready to be stored. If this test is new, or old with new keys, the FNDSLT routine is called to find a slot in the trial data file for a new record.

The PUTRUN routine is then called, using the new site code and the new test date, to write the record in the trial data file. The run number is incremented and the GETRUN routine is called, using the old site code and the old test date, to determine if another run is in the test. If so, control returns to the call to PUTRUN to rewrite the record with the new test data.

When all runs in the test have been updated and if this test is old with new keys, the records with the original keys must be deleted. The run number is set to one and the GETRUN routine is called to find the record with the original keys. Then, the PUTRUN routine is called to mark this record deleted. The run number is incremented and this process continues until all of the records with the original keys have been marked deleted.

Control then returns to the main routine.

Sample session 2 in Appendix B illustrates this routine.

VIS

The VIS routine calculates the viscosity of a gas through a method described by C. R. Wilke.[11]

First the pure gas viscosities, VS_i, are calculated for CO_2, CO, N_2, and O_2, and H_2O.

$$VS_i = \sum_{i=0}^{3} K_{ij}\ T^j$$

where

K_{ij} are the temperature coefficients for gas i,

T is the impactor temperature in Celsius.

Next the cross-term coefficients, Φ_{ij}, are calculated.

$$\Phi_{ij} = [1.0+ (VS_i/VS_j)^{1/2}(WT_j/WT_i)^{1/4}]^2/\ 2.828[1.0+(WT_i/WT_j)]^{1/2}$$

where

WT_i is the molecular weight of the pure gas.

Finally the flue gas viscosity, ETA, is calculated in poise.

$$ETA = \sum_{I=1}^{5} VS_i/\{1.0 + (1.0/F_i)[\sum_{\substack{J=1 \\ J\neq I}}^{5}(F_j)(\Phi_{ij})]\}$$

where F_j are the fractions of the wet stack gas.

WEIGHT

The WEIGHT routine is called to write a record in the weight file. These records contain the pre- and post-weights as well as a description of the substrates and the number of weights.

The WEIGHT routine first checks that IDSUBS is neither negative nor greater than the maximum index for the weight file. If it is, a warning message

*** INVALID WEIGHTS ID=nnn

is printed and control returns to the MASTER routine.

If IDSUBS equals zero, a record in the weight file available for a new set of weights is identified. The post-weights are set to zero, and the user is prompted to enter the number of weights in the set and a description ($\leq$ 40 characters) of the substrates. The user is prompted to enter the pre-weights.

If IDSUBS does not equal zero, the corresponding record in the weight file is read. If the specified weight record was entered by another contractor or someone with a different User-ID, the message

*** WEIGHT RECORD nnn BELONGS TO ANOTHER CONTRACTOR/USER
SPECIFY ANOTHER SUBSTRATE ID OR ZERO TO CONTINUE

If the user enters zero, control returns to the main routine.

If the specified record matches the current User-ID and CNTRTR, the user first is given an opportunity to change the number of weights in the set. If the number of weights is changed, the user is asked to indicate which weight(s) should be deleted or after which weight additional weight(s) should be inserted.

The pre-weights are then printed on one line and the user is asked to mark any he wishes to change by entering a character under them on the next line. If any pre-weights are changed, they are all printed again and the user is given another opportunity to change them. When no more changes are desired, the user may enter or update post-weights.

If the user selects this option and if the first post-weight is zero, he is prompted to enter the post-weights and the net weights are set to zero. If a post-weight is less than the corresponding pre-weight, a warning is printed

and the user has the option to reenter the post-weight. When all post-weights have been entered, they are printed on one line and the user has the option to change them, as previously described for the pre-weights. When no more changes are desired, a summary of the weight data showing the substrates description, the pre-weights, the post-weights, and the net weights is listed at the terminal.

The user may then make additional changes. If he wishes to change any weights, control passes to the section of the program to change pre-weights and then back through the section to update the post-weights and list the summary. When no further changes are desired, the data are written to record IDSUBS in the weight file. When the data have been stored, the message

SUBSTRATE DESCRIPTION, WEIGHTS SAVED IN RECORD nnn

is printed. Otherwise, the message

***** UNABLE TO WRITE WEIGHT RECORD nnn

is printed.

The next option is to enter or modify another weight record. If this option is selected, the user is prompted to enter another IDSUBS and control passes to the beginning of the routine. Otherwise, control returns to the main routine.

Sample session 1 in Appendix B illustrates this routine.

REFERENCES

1. Reider, J. P., and R. J. Larkin, eds. Environmental Assessment Data Systems User Guide: Fine Particle Emissions Information System. EPA 600/8-80-007, U.S. Environmental Protection Agency , 1981.

2a. Johnson, J. W., et al. A Computer-based Cascade Impactor Data Reduction System. EPA-600/7-78-042, U.S. Environmental Protection Agency, 1978.

2b. McCain, J. D., et al. A Data Reduction System for Cascade Impactors. EPA-600/7-78-132a, U.S. Environmental Protection Agency, 1978.

3. Johnson, G. L., et al. The Fine Particle Emissions Information System: A New Public Data Bank. J. Air Poll. Control Assoc. 26:643, 1976.

4. Larkin, R. J., ed. Environmental Assessment Data Systems: Systems Overview Manual. EPA-600/8-8-005, U.S. Environmental Protection Agency, NTIS No. PB80-218266, 1980.

5. Morrow, P. E. Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract. Health Physics. 12:173, 1966.

6. Mercer, T. T., M. I. Tillery, and H. Y. Chow. Operating Characteristics of Some Compressed Air Nebulizers. Am. Ind. Hyg. Assoc. J. 29:66, 1968.

7. Conte, S.D. Elementary Numerical Analysis. McGraw-Hill, New York, 1965. p. 72.

8. Smith, W. B., et al. Sampling and Data Handling Models for Inhalable Particulate Sampling. EPA-600/7-82-036, U.S. Environmental Protection Agency, 1982.

9. Scheid, Francis. Numerical Analysis. McGraw-Hill, New York, 1968. p. 65.

10. Ranz, W. E., and J. B Wong. Impaction of Dust and Smoke Particles on Surface Body Collectors. Industrial and Engineering Chemistry. 1952.

11. Wilke, C. R. A Viscosity Equation for Gas Mixtures. Journal of Chemical Physics. 8:517, 1950.

APPENDIX A

FLOWCHARTS

Appendix A: Flowcharts

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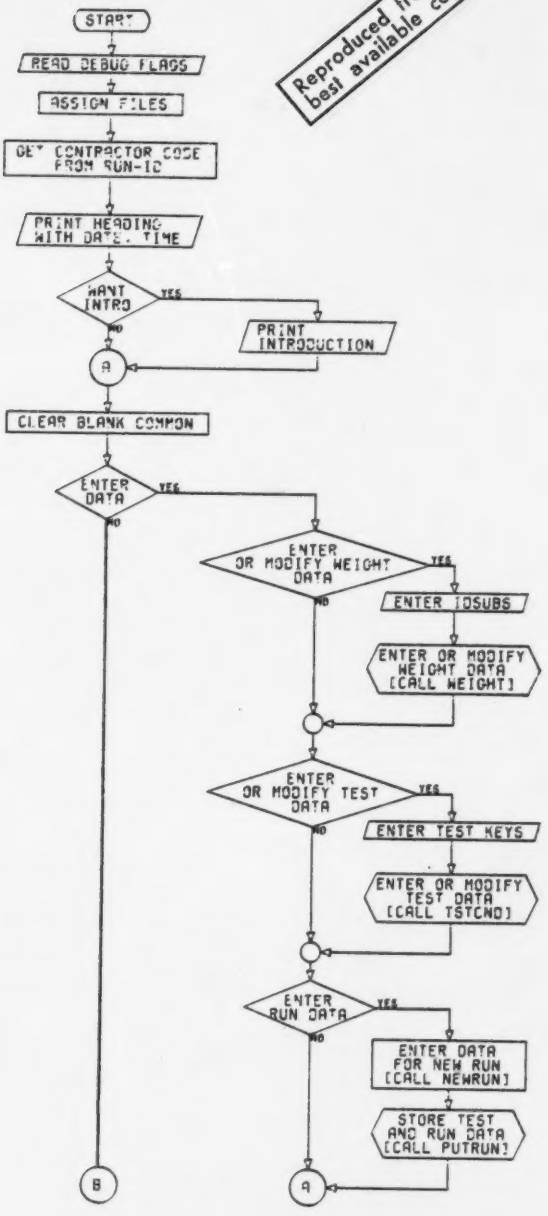
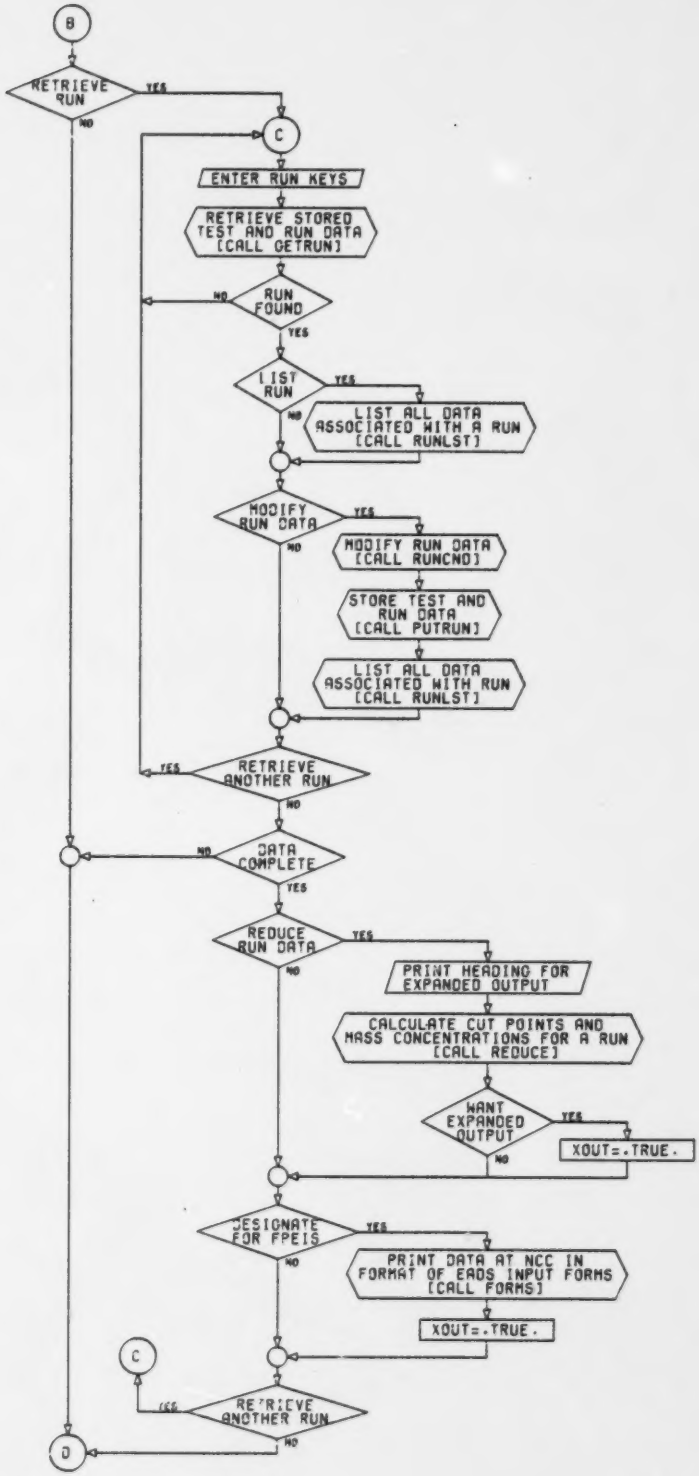
MAIN 1/3

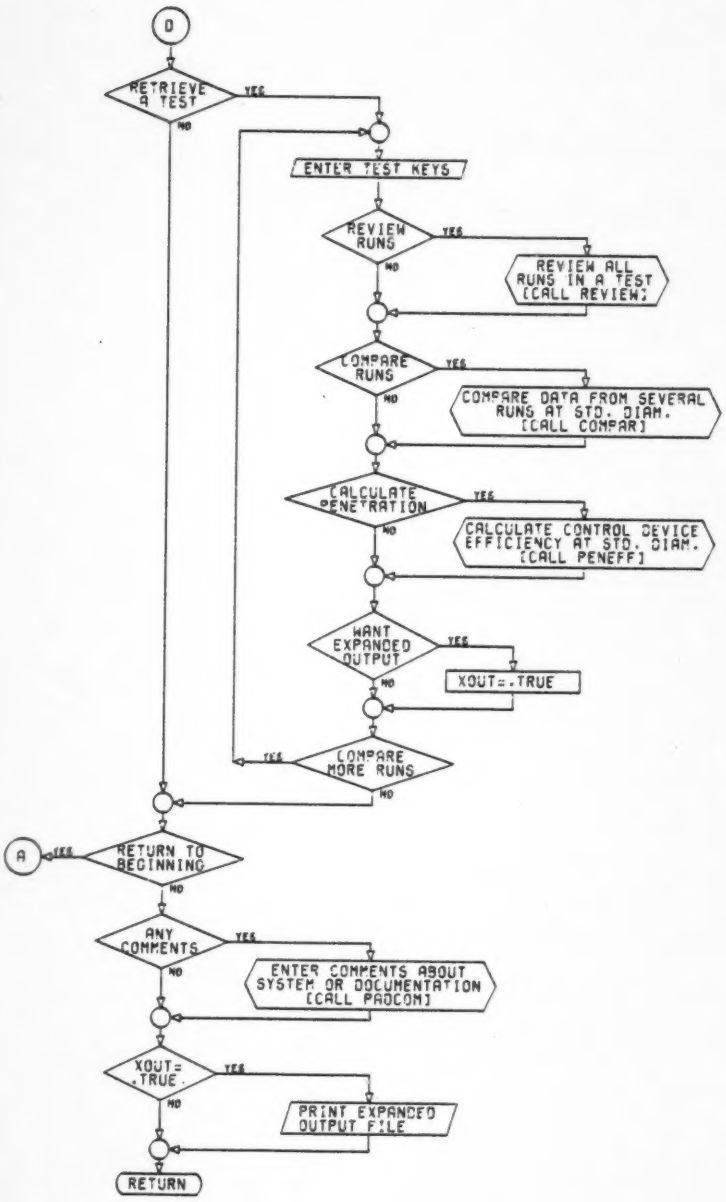
Reproduced from best available copy.



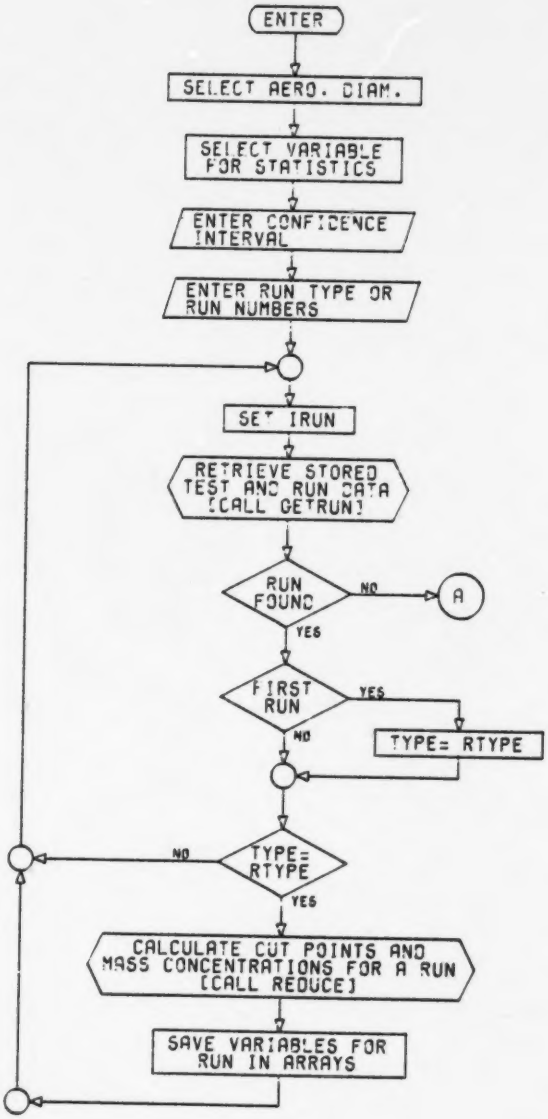
MAIN 2/3


B
RETRIEVE RUN
YES
NO
C
ENTER RUN KEYS
RETRIEVE STORED TEST AND RUN DATA [CALL GETRUN]
RUN FOUND
NO
YES
LIST RUN
YES
NO
LIST ALL DATA ASSOCIATED WITH A RUN [CALL RUNLST]
MODIFY RUN DATA
YES
NO
MODIFY RUN DATA [CALL RUNCND]
STORE TEST AND RUN DATA [CALL PUTRUN]
LIST ALL DATA ASSOCIATED WITH RUN [CALL RUNLST]
RETRIEVE ANOTHER RUN
YES
NO
DATA COMPLETE
NO
YES
REDUCE RUN DATA
YES
NO
PRINT HEADING FOR EXPANDED OUTPUT
CALCULATE CUT POINTS AND MASS CONCENTRATIONS FOR A RUN [CALL REDUCE]
WANT EXPANDED OUTPUT
YES
NO
XOUT=.TRUE.
DESIGNATE FOR FPEIS
YES
NO
PRINT DATA AT NCC IN FORMAT OF EADS INPUT FORMS [CALL FORMS]
XOUT=.TRUE.
C
RETRIEVE ANOTHER RUN
YES
NO
D

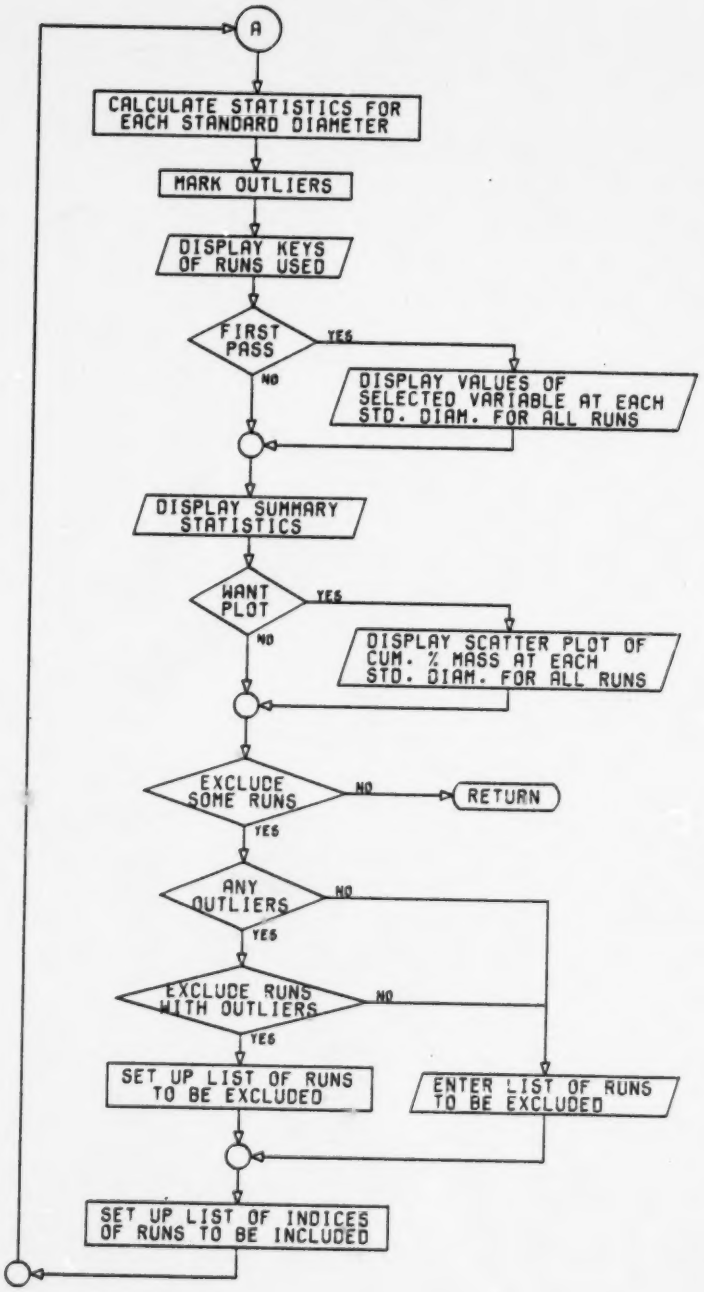
MAIN 3/3


D
RETRIEVE A TEST
YES
NO
ENTER TEST KEYS
REVIEW RUNS
YES
NO
REVIEW ALL RUNS IN A TEST [CALL REVIEW]
COMPARE RUNS
YES
NO
COMPARE DATA FROM SEVERAL RUNS AT STD. DIAM. [CALL COMPAR]
CALCULATE PENETRATION
YES
NO
CALCULATE CONTROL DEVICE EFFICIENCY AT STD. DIAM. [CALL PENEFF]
WANT EXPANDED OUTPUT
YES
NO
XOUT=.TRUE
COMPARE MORE RUNS
YES
NO
A
YES
RETURN TO BEGINNING
NO
ANY COMMENTS
YES
NO
ENTER COMMENTS ABOUT SYSTEM OR DOCUMENTATION [CALL PADCOM]
XOUT= .TRUE.
YES
NO
PRINT EXPANDED OUTPUT FILE
RETURN

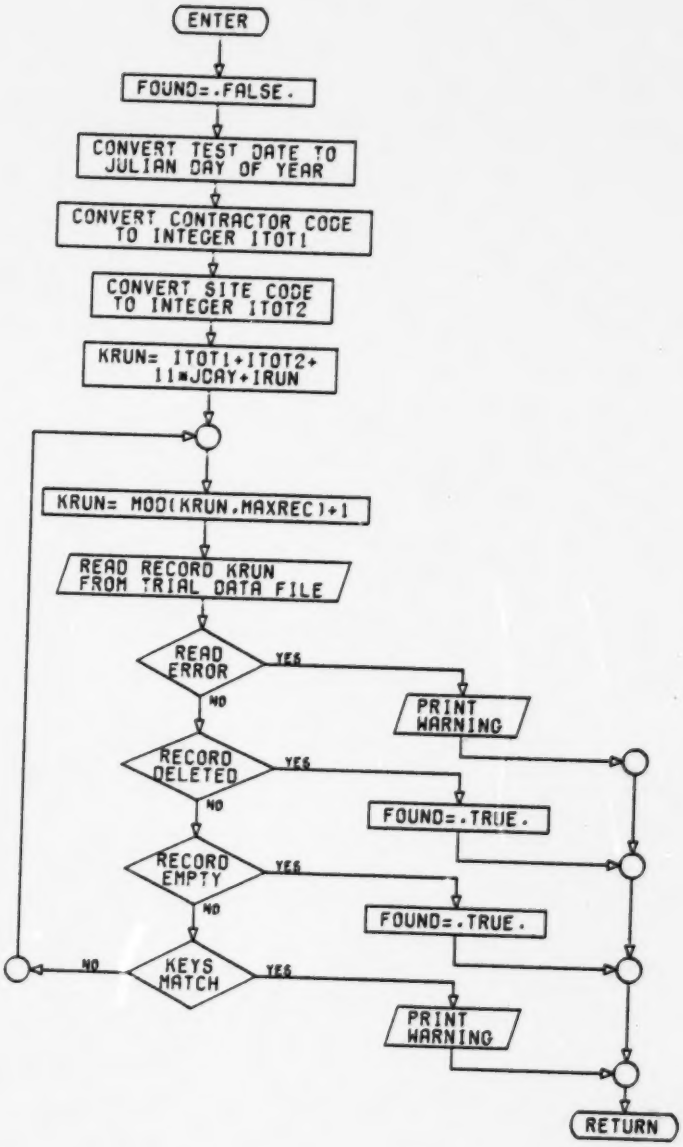
COMPAR 1/2


ENTER
SELECT AERO. DIAM.
SELECT VARIABLE FOR STATISTICS
ENTER CONFIDENCE INTERVAL
ENTER RUN TYPE OR RUN NUMBERS
SET IRUN
RETRIEVE STORED TEST AND RUN DATA [CALL GETRUN]
RUN FOUND
NO
A
YES
FIRST RUN
YES
TYPE= RTYPE
NO
TYPE= RTYPE
NO
YES
CALCULATE CUT POINTS AND MASS CONCENTRATIONS FOR A RUN [CALL REDUCE]
SAVE VARIABLES FOR RUN IN ARRAYS

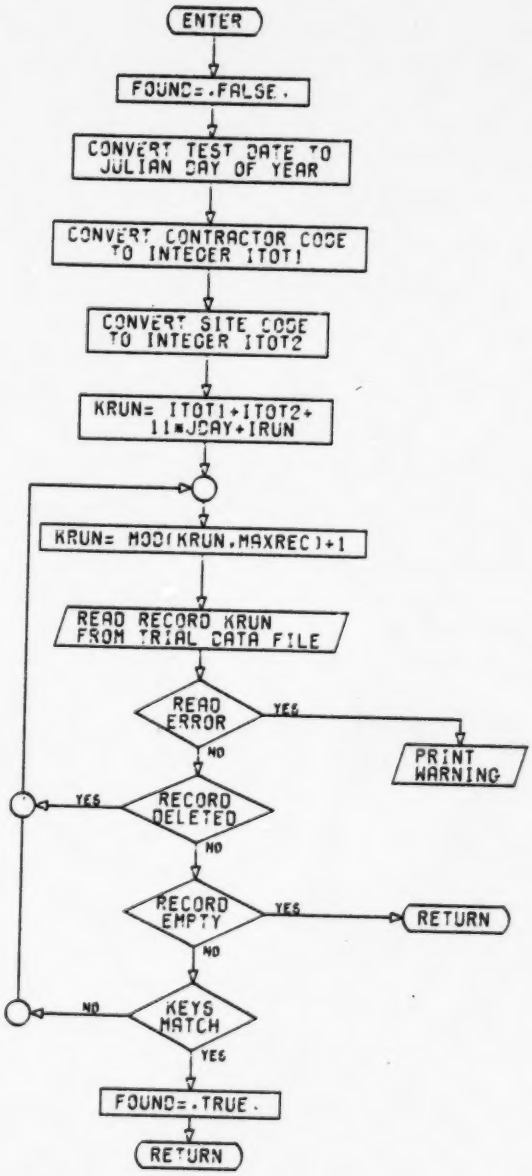
COMPAR 2

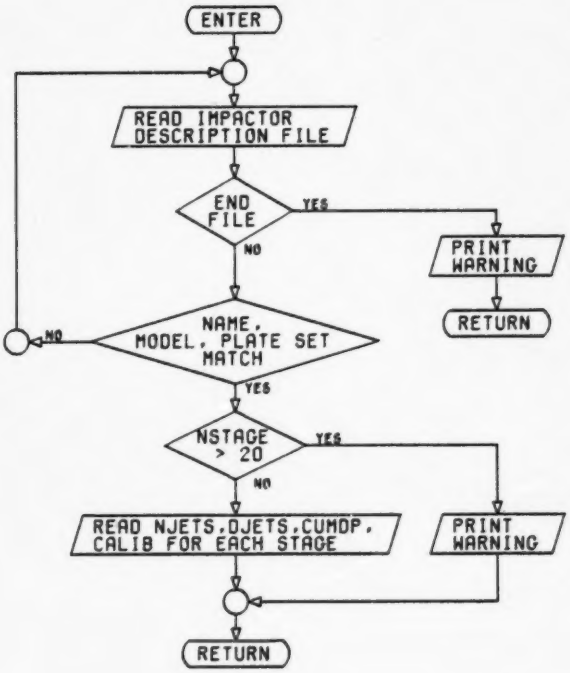

A
CALCULATE STATISTICS FOR EACH STANDARD DIAMETER
MARK OUTLIERS
DISPLAY KEYS OF RUNS USED
FIRST PASS
YES
NO
DISPLAY VALUES OF SELECTED VARIABLE AT EACH STD. DIAM. FOR ALL RUNS
DISPLAY SUMMARY STATISTICS
WANT PLOT
YES
NO
DISPLAY SCATTER PLOT OF CUM. % MASS AT EACH STD. DIAM. FOR ALL RUNS
EXCLUDE SOME RUNS
NO
RETURN
YES
ANY OUTLIERS
NO
YES
EXCLUDE RUNS WITH OUTLIERS
NO
YES
SET UP LIST OF RUNS TO BE EXCLUDED
ENTER LIST OF RUNS TO BE EXCLUDED
SET UP LIST OF INDICES OF RUNS TO BE INCLUDED

FNDSLT

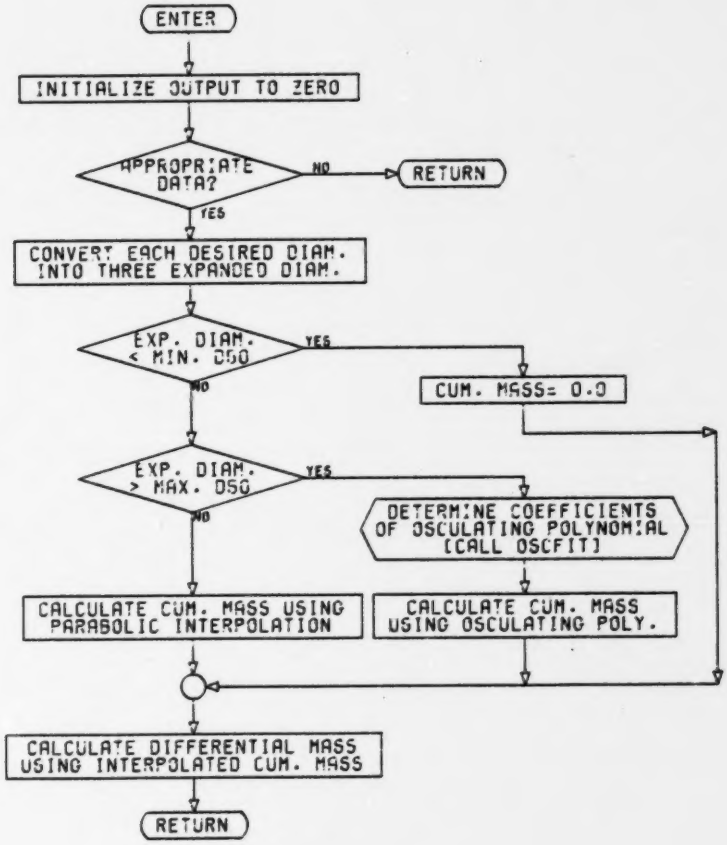

ENTER
FOUND=.FALSE.
CONVERT TEST DATE TO JULIAN DAY OF YEAR
CONVERT CONTRACTOR CODE TO INTEGER ITOT1
CONVERT SITE CODE TO INTEGER ITOT2
KRUN= ITOT1+ITOT2+ 11*JDAY+IRUN
KRUN= MOD(KRUN,MAXREC)+1
READ RECORD KRUN FROM TRIAL DATA FILE
READ ERROR
YES
NO
PRINT WARNING
RECORD DELETED
YES
NO
FOUND=.TRUE.
RECORD EMPTY
YES
NO
FOUND=.TRUE.
KEYS MATCH
NO
YES
PRINT WARNING
RETURN

GETRUN

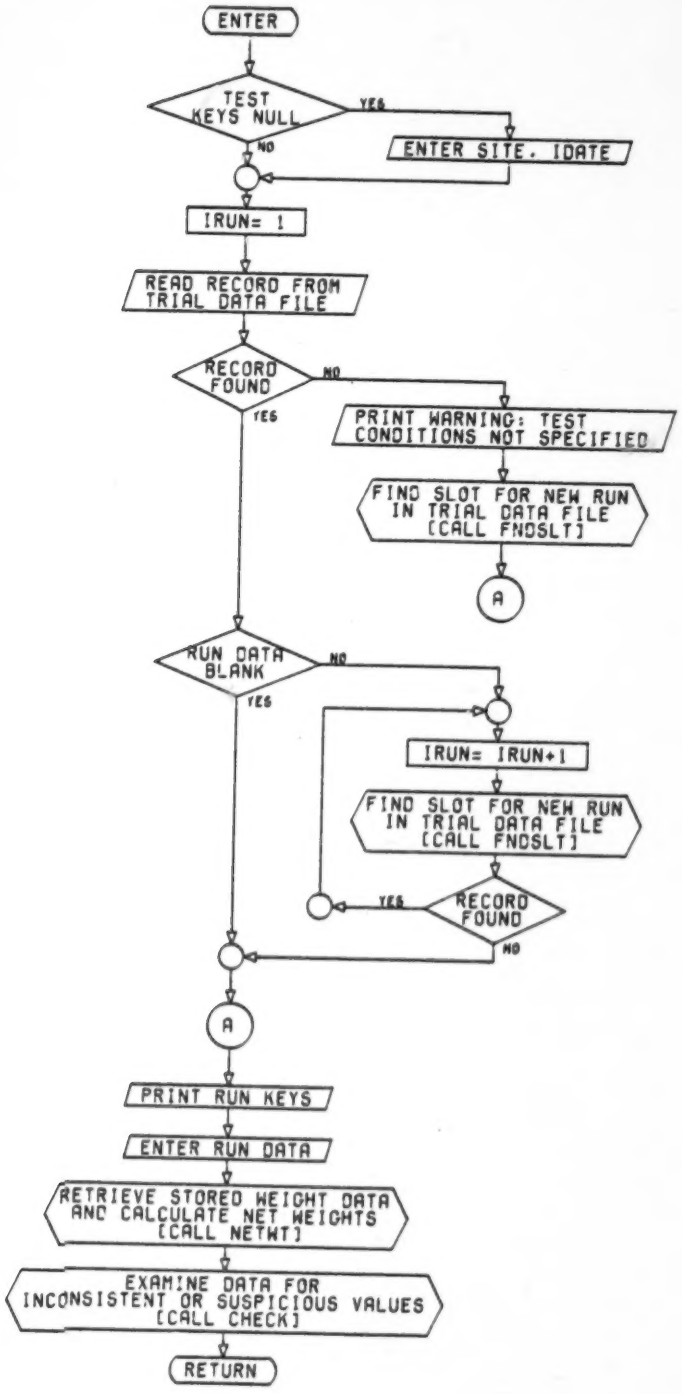

ENTER
FOUND=.FALSE.
CONVERT TEST DATE TO JULIAN DAY OF YEAR
CONVERT CONTRACTOR CODE TO INTEGER ITOT1
CONVERT SITE CODE TO INTEGER ITOT2
KRUN= ITOT1+ITOT2+ 11*JDAY+IRUN
KRUN= MOD(KRUN,MAXREC)+1
READ RECORD KRUN FROM TRIAL DATA FILE
READ ERROR
YES
PRINT WARNING
NO
YES
RECORD DELETED
NO
RECORD EMPTY
YES
RETURN
NO
NO
KEYS MATCH
YES
FOUND=.TRUE.
RETURN

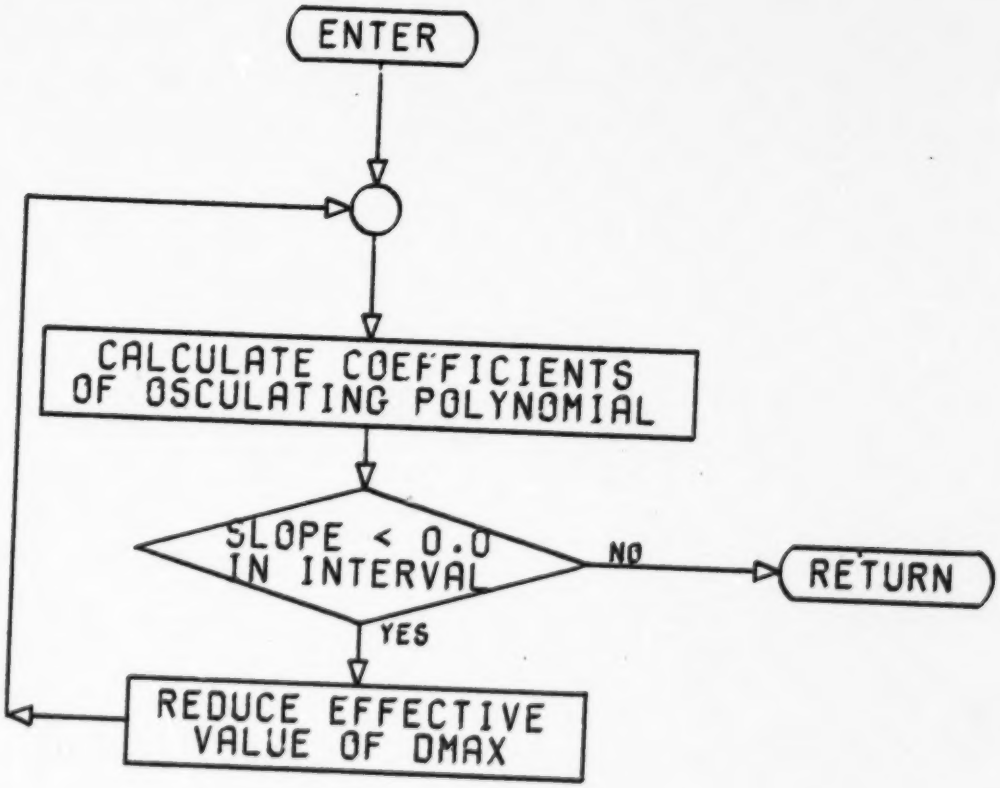

ENTER
READ IMPACTOR DESCRIPTION FILE
END FILE
YES
NO
PRINT WARNING
RETURN
NAME, MODEL, PLATE SET MATCH
NO
YES
NSTAGE > 20
YES
NO
READ NJETS,DJETS,CUMDP, CALIB FOR EACH STAGE
PRINT WARNING
RETURN

INTERP

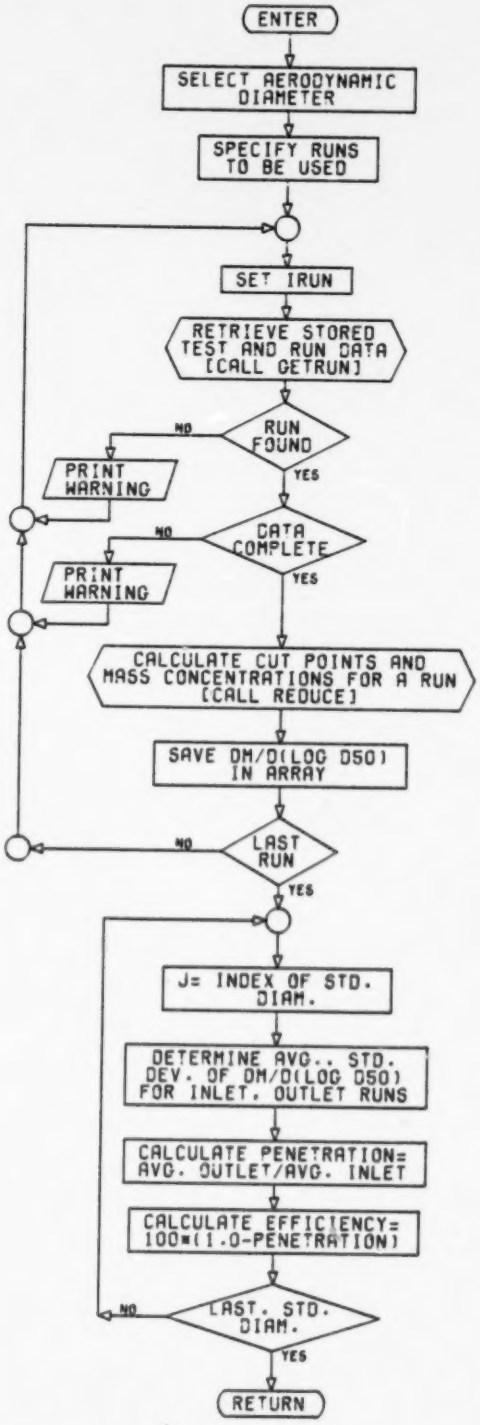

ENTER
INITIALIZE OUTPUT TO ZERO
APPROPRIATE DATA?
NO
RETURN
YES
CONVERT EACH DESIRED DIAM. INTO THREE EXPANDED DIAM.
EXP. DIAM. < MIN. D50
YES
NO
CUM. MASS= 0.0
EXP. DIAM. > MAX. D50
YES
NO
DETERMINE COEFFICIENTS OF OSCULATING POLYNOMIAL [CALL OSCFIT]
CALCULATE CUM. MASS USING PARABOLIC INTERPOLATION
CALCULATE CUM. MASS USING OSCULATING POLY.
CALCULATE DIFFERENTIAL MASS USING INTERPOLATED CUM. MASS
RETURN

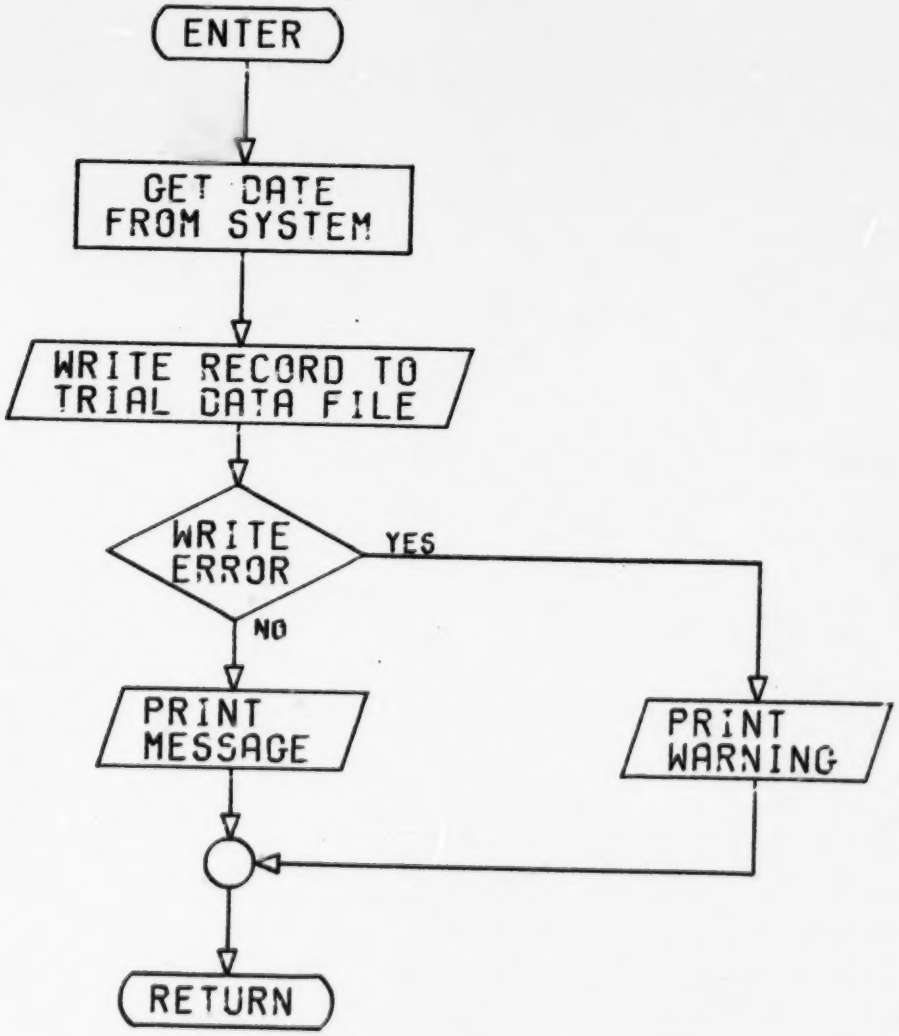
NEWRUN


ENTER
TEST KEYS NULL
YES
NO
ENTER SITE, IDATE
IRUN= 1
READ RECORD FROM TRIAL DATA FILE
RECORD FOUND
NO
YES
PRINT WARNING: TEST CONDITIONS NOT SPECIFIED
FIND SLOT FOR NEW RUN IN TRIAL DATA FILE [CALL FNDSLT]
A
RUN DATA BLANK
NO
YES
IRUN= IRUN+1
FIND SLOT FOR NEW RUN IN TRIAL DATA FILE [CALL FNDSLT]
RECORD FOUND
YES
NO
A
PRINT RUN KEYS
ENTER RUN DATA
RETRIEVE STORED WEIGHT DATA AND CALCULATE NET WEIGHTS [CALL NETWT]
EXAMINE DATA FOR INCONSISTENT OR SUSPICIOUS VALUES [CALL CHECK]
RETURN

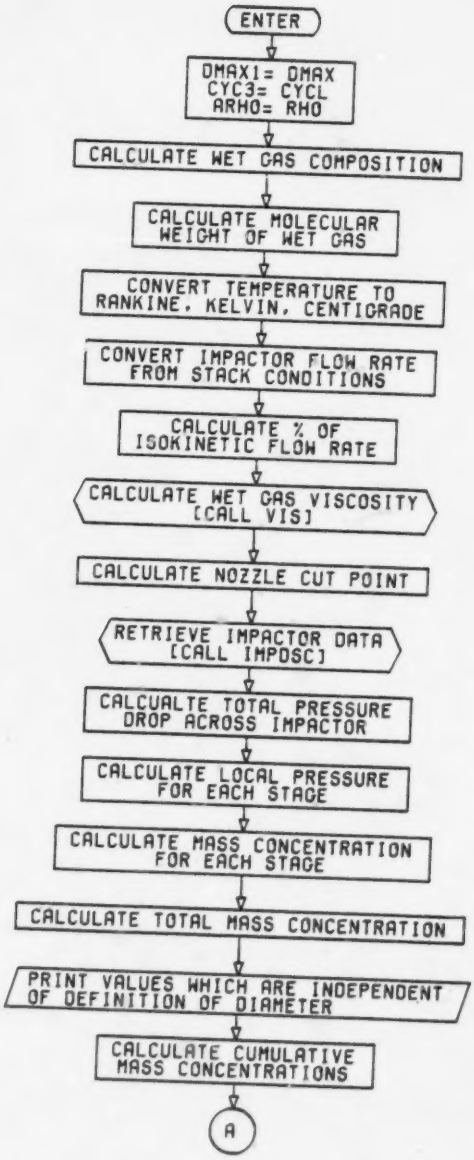

ENTER
CALCULATE COEFFICIENTS OF OSCULATING POLYNOMIAL
SLOPE < 0.0 IN INTERVAL
NO
RETURN
YES
REDUCE EFFECTIVE VALUE OF DMAX

PENEFF

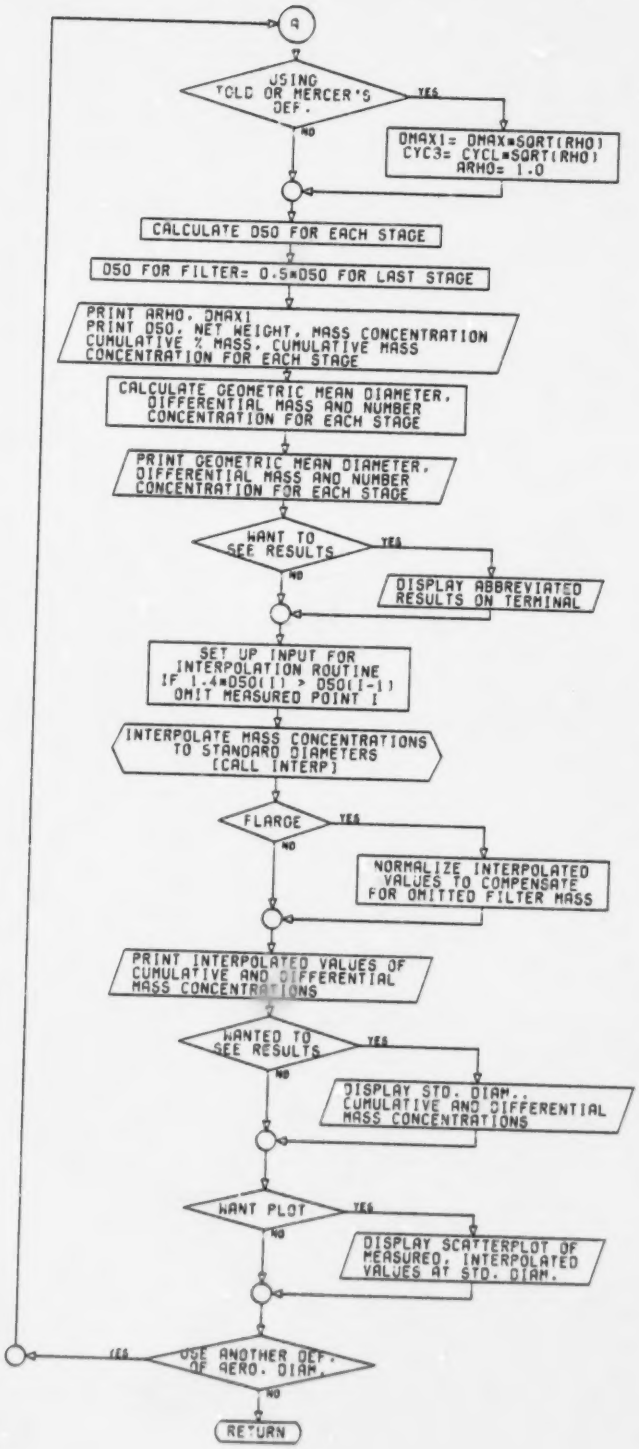

ENTER
SELECT AERODYNAMIC DIAMETER
SPECIFY RUNS TO BE USED
SET IRUN
RETRIEVE STORED TEST AND RUN DATA [CALL GETRUN]
RUN FOUND
NO
YES
PRINT WARNING
DATA COMPLETE
NO
YES
PRINT WARNING
CALCULATE CUT POINTS AND MASS CONCENTRATIONS FOR A RUN [CALL REDUCE]
SAVE DM/D(LOG D50) IN ARRAY
LAST RUN
NO
YES
J= INDEX OF STD. DIAM.
DETERMINE AVG., STD. DEV. OF DM/D(LOG D50) FOR INLET, OUTLET RUNS
CALCULATE PENETRATION= AVG. OUTLET/AVG. INLET
CALCULATE EFFICIENCY= 100*(1.0-PENETRATION)
LAST, STD. DIAM.
NO
YES
RETURN

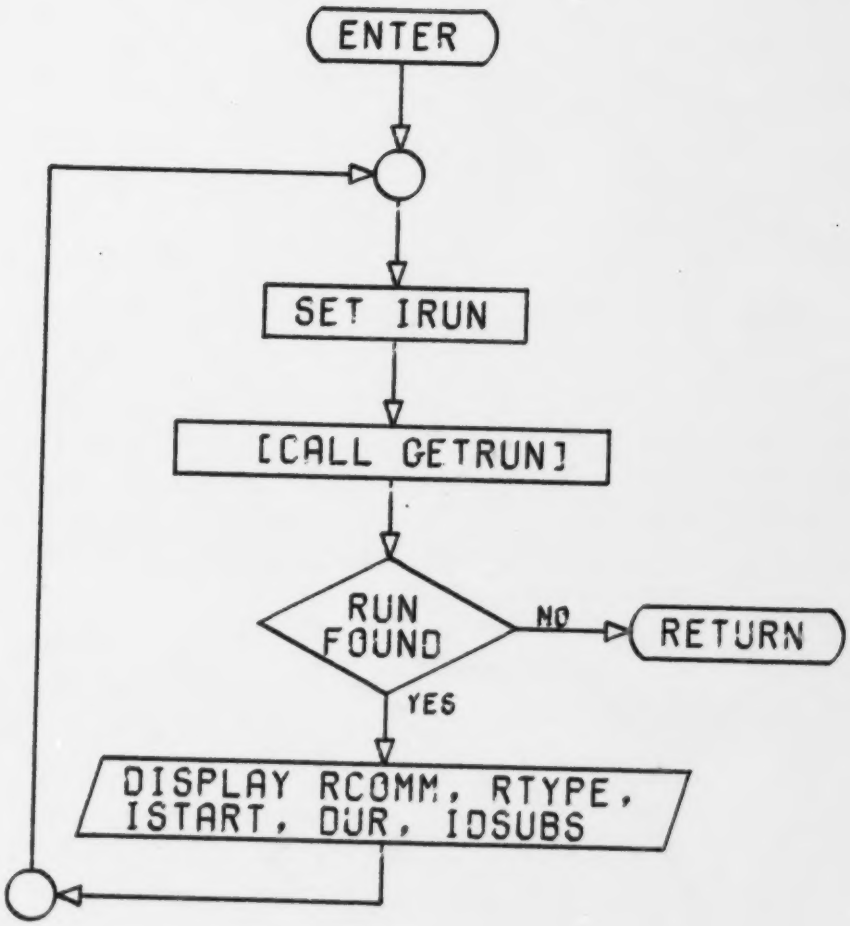

ENTER
GET DATE FROM SYSTEM
WRITE RECORD TO TRIAL DATA FILE
WRITE ERROR
YES
NO
PRINT MESSAGE
PRINT WARNING
RETURN

REDUCE 1/2

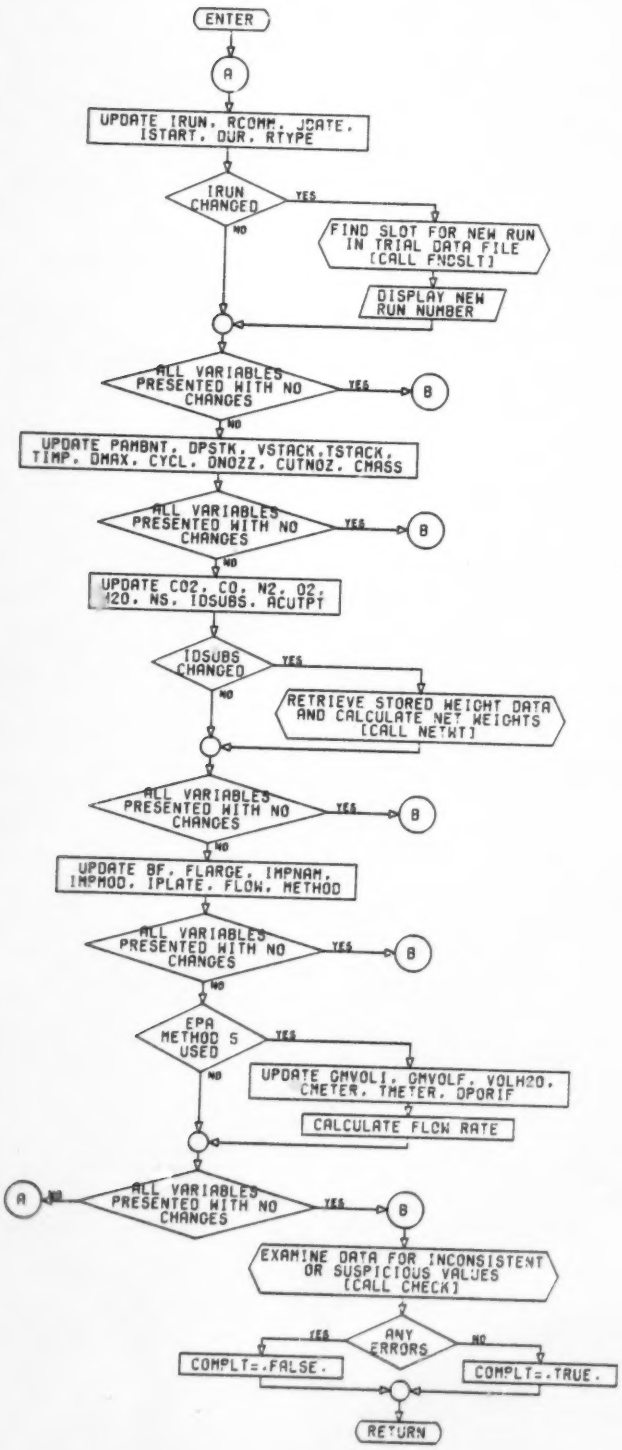

ENTER
DMAX1= DMAX
CYC3= CYCL
ARHO= RHO
CALCULATE WET GAS COMPOSITION
CALCULATE MOLECULAR WEIGHT OF WET GAS
CONVERT TEMPERATURE TO RANKINE, KELVIN, CENTIGRADE
CONVERT IMPACTOR FLOW RATE FROM STACK CONDITIONS
CALCULATE % OF ISOKINETIC FLOW RATE
CALCULATE WET GAS VISCOSITY [CALL VIS]
CALCULATE NOZZLE CUT POINT
RETRIEVE IMPACTOR DATA [CALL IMPDSC]
CALCUALTE TOTAL PRESSURE DROP ACROSS IMPACTOR
CALCULATE LOCAL PRESSURE FOR EACH STAGE
CALCULATE MASS CONCENTRATION FOR EACH STAGE
CALCULATE TOTAL MASS CONCENTRATION
PRINT VALUES WHICH ARE INDEPENDENT OF DEFINITION OF DIAMETER
CALCULATE CUMULATIVE MASS CONCENTRATIONS
A

REDUCE 2/2

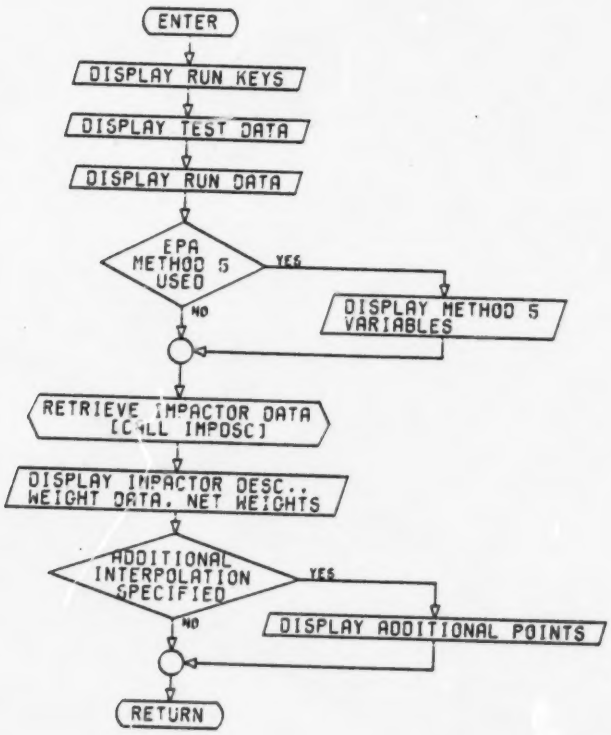

A
USING TOLD OR MERCER'S DEF.
YES
NO
DMAX1= DMAX*SQRT(RHO)
CYC3= CYCL*SQRT(RHO)
ARHO= 1.0
CALCULATE D50 FOR EACH STAGE
D50 FOR FILTER= 0.5*D50 FOR LAST STAGE
PRINT ARHO, DMAX1
PRINT D50, NET WEIGHT, MASS CONCENTRATION CUMULATIVE % MASS, CUMULATIVE MASS CONCENTRATION FOR EACH STAGE
CALCULATE GEOMETRIC MEAN DIAMETER, DIFFERENTIAL MASS AND NUMBER CONCENTRATION FOR EACH STAGE
PRINT GEOMETRIC MEAN DIAMETER, DIFFERENTIAL MASS AND NUMBER CONCENTRATION FOR EACH STAGE
WANT TO SEE RESULTS
YES
NO
DISPLAY ABBREVIATED RESULTS ON TERMINAL
SET UP INPUT FOR INTERPOLATION ROUTINE IF 1.4*D50(I) > D50(I-1) OMIT MEASURED POINT I
INTERPOLATE MASS CONCENTRATIONS TO STANDARD DIAMETERS (CALL INTERP)
FLARGE
YES
NO
NORMALIZE INTERPOLATED VALUES TO COMPENSATE FOR OMITTED FILTER MASS
PRINT INTERPOLATED VALUES OF CUMULATIVE AND DIFFERENTIAL MASS CONCENTRATIONS
WANTED TO SEE RESULTS
YES
NO
DISPLAY STD. DIAM., CUMULATIVE AND DIFFERENTIAL MASS CONCENTRATIONS
WANT PLOT
YES
NO
DISPLAY SCATTERPLOT OF MEASURED, INTERPOLATED VALUES AT STD. DIAM.
USE ANOTHER DEF. OF AERO. DIAM.
YES
NO
RETURN


ENTER
SET IRUN
[CALL GETRUN]
RUN FOUND
NO
RETURN
YES
DISPLAY RCOMM, RTYPE, ISTART, DUR, IDSUBS

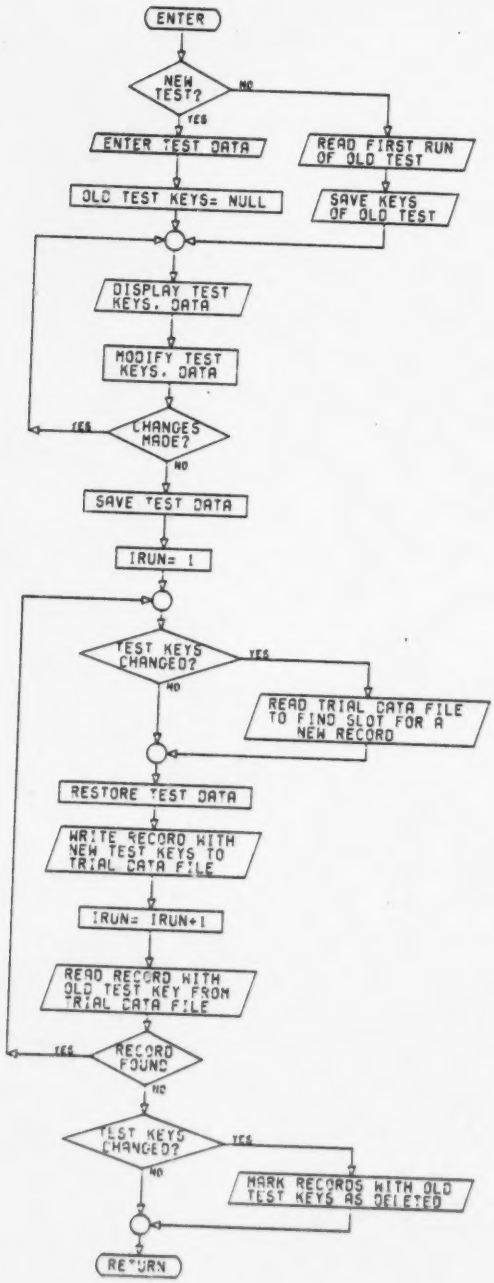
RUNCND

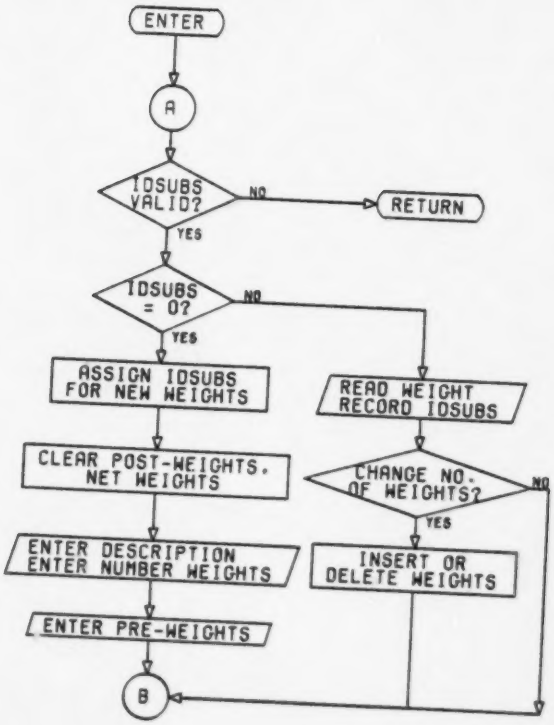

ENTER
A
UPDATE IRUN, RCOMM, JDATE, ISTART, DUR, RTYPE
IRUN CHANGED
YES
NO
FIND SLOT FOR NEW RUN IN TRIAL DATA FILE [CALL FNDSLT]
DISPLAY NEW RUN NUMBER
ALL VARIABLES PRESENTED WITH NO CHANGES
YES
B
NO
UPDATE PAMBNT, DPSTK, VSTACK, TSTACK, TIMP, DMAX, CYCL, DNOZZ, CUTNOZ, CMASS
ALL VARIABLES PRESENTED WITH NO CHANGES
YES
B
NO
UPDATE CO2, CO, N2, O2, H2O, NS, IDSUBS, ACUTPT
IDSUBS CHANGED
YES
NO
RETRIEVE STORED WEIGHT DATA AND CALCULATE NET WEIGHTS [CALL NETWT]
ALL VARIABLES PRESENTED WITH NO CHANGES
YES
B
NO
UPDATE BF, FLARGE, IMPNAM, IMPMOD, IPLATE, FLOW, METHOD
ALL VARIABLES PRESENTED WITH NO CHANGES
YES
B
NO
EPA METHOD 5 USED
YES
NO
UPDATE CMVOLI, CMVOLF, VOLH2O, CMETER, TMETER, DPORIF
CALCULATE FLOW RATE
A
NO
ALL VARIABLES PRESENTED WITH NO CHANGES
YES
B
EXAMINE DATA FOR INCONSISTENT OR SUSPICIOUS VALUES [CALL CHECK]
ANY ERRORS
YES
NO
COMPLT=.FALSE.
COMPLT=.TRUE.
RETURN

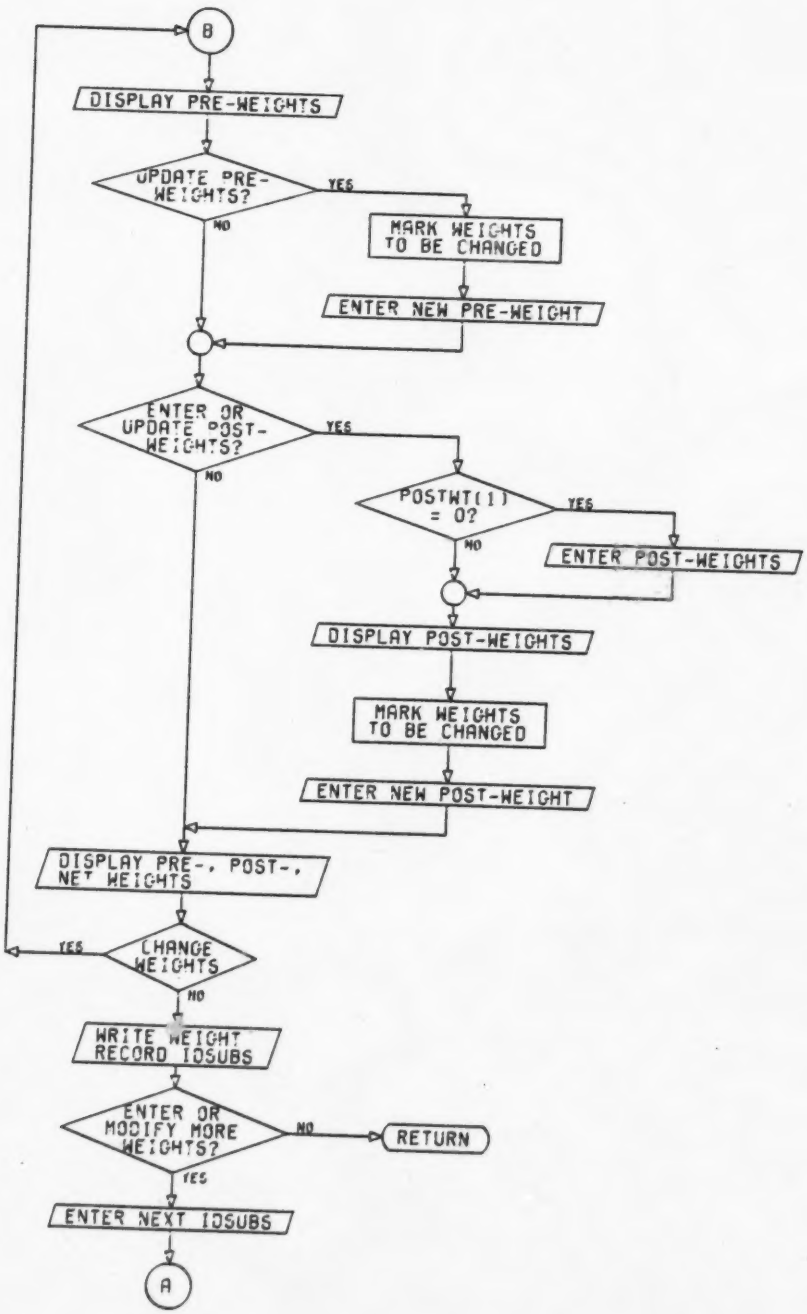
RUNLST


ENTER
DISPLAY RUN KEYS
DISPLAY TEST DATA
DISPLAY RUN DATA
EPA METHOD 5 USED
YES
NO
DISPLAY METHOD 5 VARIABLES
RETRIEVE IMPACTOR DATA [CALL IMPOSC]
DISPLAY IMPACTOR DESC., WEIGHT DATA, NET WEIGHTS
ADDITIONAL INTERPOLATION SPECIFIED
YES
NO
DISPLAY ADDITIONAL POINTS
RETURN

TSTCND


ENTER
NEW TEST?
NO
YES
ENTER TEST DATA
READ FIRST RUN OF OLD TEST
OLD TEST KEYS= NULL
SAVE KEYS OF OLD TEST
DISPLAY TEST KEYS, DATA
MODIFY TEST KEYS, DATA
CHANGES MADE?
YES
NO
SAVE TEST DATA
IRUN= 1
TEST KEYS CHANGED?
YES
NO
READ TRIAL DATA FILE TO FIND SLOT FOR A NEW RECORD
RESTORE TEST DATA
WRITE RECORD WITH NEW TEST KEYS TO TRIAL DATA FILE
IRUN= IRUN+1
READ RECORD WITH OLD TEST KEY FROM TRIAL DATA FILE
RECORD FOUND
YES
NO
TEST KEYS CHANGED?
YES
NO
MARK RECORDS WITH OLD TEST KEYS AS DELETED
RETURN


ENTER
A
IDSUBS VALID?
NO
RETURN
YES
IDSUBS = 0?
NO
YES
ASSIGN IDSUBS FOR NEW WEIGHTS
READ WEIGHT RECORD IDSUBS
CLEAR POST-WEIGHTS, NET WEIGHTS
CHANGE NO. OF WEIGHTS?
NO
YES
ENTER DESCRIPTION ENTER NUMBER WEIGHTS
INSERT OR DELETE WEIGHTS
ENTER PRE-WEIGHTS
B


B
DISPLAY PRE-WEIGHTS
UPDATE PRE-WEIGHTS?
YES
NO
MARK WEIGHTS TO BE CHANGED
ENTER NEW PRE-WEIGHT
ENTER OR UPDATE POST-WEIGHTS?
YES
NO
POSTWT(1) = 0?
YES
NO
ENTER POST-WEIGHTS
DISPLAY POST-WEIGHTS
MARK WEIGHTS TO BE CHANGED
ENTER NEW POST-WEIGHT
DISPLAY PRE-, POST-, NET WEIGHTS
CHANGE WEIGHTS
YES
NO
WRITE WEIGHT RECORD IDSUBS
ENTER OR MODIFY MORE WEIGHTS?
NO
RETURN
YES
ENTER NEXT IDSUBS
A

APPENDIX B

SAMPLE SESSIONS

Appendix B: Sample Sessions

B- 1. Entry of presampling substrate weights . . . . . B- 3

B- 2. Entry of postsampling substrate weights; modifying substrate weights . . . . . B- 4

B- 3. Entering test data . . . . . B- 5

B- 4. Entering run data . . . . . B- 6

B- 5. Reviewing run data . . . . . B- 7

B- 6. Modifying run data . . . . . B- 8

B- 7. Reducing run data . . . . . B- 9

B- 8. Expanded output: reduced data (at NCC) B-11

B- 9. FPEIS coding forms (at NCC) B-13

B-10. Reviewing all runs in a test B-14

B-11. Comparing several runs B-15

B-12. Calculating penetration and efficiency B-19

```
DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>Y

DO YOU WISH TO ENTER OR MODIFY ANY WEIGHTS? ENTER Y OR N
>Y
ENTER ID OF SUBSTRATES YOU WISH TO MODIFY OR 0 (ZERO) FOR A NEW SET
>0
 THE ID ASSIGNED TO THESE SUBSTRATES IS    21
*** RECORD THIS VALUE IN YOUR NOTEBOOK
ENTER NUMBER OF WEIGHTS IN SET
>9
ENTER SUBSTRATE DESCRIPTION
>GREASED FOIL
PLEASE ENTER ALL WEIGHTS IN UNITS OF MILLIGRAMS (MG)
ORDER OF WEIGHTS SHOULD BE LARGEST PARTICLES, ..., SMALLEST PARTICLES
STAGE1, ..., STAGE N, BACKUP FILTER (IF USED)
ENTER PRE-WEIGHT   1
>10.0
ENTER PRE-WEIGHT   2
>10.
ENTER PRE-WEIGHT   3
>10
ENTER PRE-WEIGHT   4
>10
ENTER PRE-WEIGHT   5
>0
*** PRE-WEIGHT MUST BE > 0.0, NOT     .0000
ENTER PRE-WEIGHT   5
>10
ENTER PRE-WEIGHT   6
>10
ENTER PRE-WEIGHT   7
>10
ENTER PRE-WEIGHT   8
>10
ENTER PRE-WEIGHT   9
>10
 PRE-WEIGHTS
 10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
ENTER A MARK UNDER THE ITEM YOU WISH TO CHANGE OR RETURN
>
DO YOU WISH TO ENTER OR UPDATE ANY POST-WEIGHTS? ENTER Y OR N
>N
SUBSTRATES DESCRIPTION: GREASED FOIL
SUBSTRATE  PRE-WEIGHT  POST-WEIGHT   NET MASS (MG)
   1       10.000        .000         .000
   2       10.000        .000         .000
   3       10.000        .000         .000
   4       10.000        .000         .000
   5       10.000        .000         .000
   6       10.000        .000         .000
   7       10.000        .000         .000
   8       10.000        .000         .000
   9       10.000        .000         .000
DO YOU WISH TO CHANGE THE SUBSTRATES DESCRIPTION? ENTER Y OR N
>N
DO YOU WISH TO CHANGE ANY WEIGHTS?  ENTER Y OR N
>N
SUBSTRATE DESCRIPTION, WEIGHTS SAVED IN RECORD          21
DO YOU WISH TO ENTER OR MODIFY MORE WEIGHTS? ENTER Y OR N
>N

DO YOU WISH TO ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>N
```

Figure B-1. Entry of presampling substrate weights

```
DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>Y

DO YOU WISH TO ENTER OR MODIFY ANY WEIGHTS? ENTER Y OR N
>Y
ENTER ID OF SUBSTRATES YOU WISH TO MODIFY OR 0 (ZERO) FOR A NEW SET
>21
DO YOU WISH TO CHANGE THE NUMBER OF WEIGHTS IN THE SET?  ENTER Y OR N
>N
 PRE-WEIGHTS
 10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000  10.000
ENTER A MARK UNDER THE ITEM YOU WISH TO CHANGE OR RETURN
>
DO YOU WISH TO ENTER OR UPDATE ANY POST-WEIGHTS? ENTER Y OR N
>Y
ENTER POST-WEIGHT   1
>11.22
ENTER POST-WEIGHT   2
>11.29
ENTER POST-WEIGHT   3
>10.58
ENTER POST-WEIGHT   4
>10.18
ENTER POST-WEIGHT   5
>11.53
ENTER POST-WEIGHT   6
>14.39
ENTER POST-WEIGHT   7
>11.90
ENTER POST-WEIGHT   8
>10.54
ENTER POST-WEIGHT   9
>10.54
 POST-WEIGHTS
 11.220  11.290  10.580  10.180  11.530  14.390  11.900  10.540  10.540
ENTER A MARK UNDER THE ITEM YOU WISH TO CHANGE OR RETURN
>          X                                              X
ENTER POST-WEIGHT   2
>10.29
ENTER POST-WEIGHT   8
>10.39
 POST-WEIGHTS
 11.220  10.290  10.580  10.180  11.530  14.390  11.900  10.390  10.540
ENTER A MARK UNDER THE ITEM YOU WISH TO CHANGE OR RETURN
>
SUBSTRATES DESCRIPTION: GREASED FOIL
SUBSTRATE   PRE-WEIGHT   POST-WEIGHT    NET MASS (MG)
    1        10.000        11.220          1.220
    2        10.000        10.290           .290
    3        10.000        10.580           .580
    4        10.000        10.180           .180
    5        10.000        11.530          1.530
    6        10.000        14.390          4.390
    7        10.000        11.900          1.900
    8        10.000        10.390           .390
    9        10.000        10.540           .540
DO YOU WISH TO CHANGE THE SUBSTRATES DESCRIPTION? ENTER Y OR N
>N
DO YOU WISH TO CHANGE ANY WEIGHTS?  ENTER Y OR N
>N
SUBSTRATE DESCRIPTION, WEIGHTS SAVED IN RECORD           21
DO YOU WISH TO ENTER OR MODIFY MORE WEIGHTS? ENTER Y OR N
>N

DO YOU WISH TO ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>N
```

Figure B-2. Entry of postsampling substrate weights; modifying substrate weights

```
DO YOU WISH TO ENTER OR MODIFY ANY WEIGHTS? ENTER Y OR N
>N

DO YOU WISH TO ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>Y
ENTER SITE CODE, SITE (4 CHAR)
>RTP
ENTER TEST DATE, IDATE, (MMDDYY)
>032183
DO YOU WISH TO ENTER DATA FOR A NEW TEST?  ENTER Y OR N
>Y
ENTER TEST COMMENTS, TCOMM, (<= 80 CHAR)
>Demonstrate PADRE with sample Andersen data from CIDRS manual
ENTER PARTICLE DENSITY, RHO (GM/CC)
>2.4
CNTRTR= RTI   SITE= RTP   IDATE=  32183 TCOMM=
Demonstrate PADRE with sample Andersen data from CIDRS manual
RHO=    2.40000
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
  SITE    IDATE   TCOMM   RHO
>
DATA FOR RUN  1 BY RTI  AT RTP  ON  32183 HAS BEEN SAVED IN THE TRIAL DATA FILE

DO YOU WISH TO ENTER DATA FOR A RUN? ENTER Y OR N.
>N
```

Figure B-3. Entering test data

```
DO YOU WISH TO ENTER OR MODIFY ANY TEST DATA?  ENTER Y OR N.
>N

DO YOU WISH TO ENTER DATA FOR A RUN? ENTER Y OR N.
>Y

THE COMPLETE ID FOR THIS RUN IS CNTRTR=RTI  SITE=RTP  IDATE= 32183 IRUN= 1
*** RECORD THESE VALUES IN YOUR NOTEBOOK

ENTER RUN COMMENTS, RCOMM
>Demonstrate PADRE's capability to accept free form comments
ENTER DATE OF RUN, JDATE, AS MMDDYY
>32383
ENTER STARTING TIME OF RUN, ISTART, AS HHMM (24 HR CLOCK)
>1000
ENTER DURATION OF RUN, DUR, IN MINUTES
>60
ENTER RUN TYPE, RTYPE; I FOR INLET, O FOR OUTLET
>o
*** THE CHARACTER o IS NOT APPROVED FOR CODES.  RE-ENTER CODE o
>O
ENTER PERCENT H2O IN STACK GAS
>8
ENTER COMPOSITION OF DRY STACK GAS
ENTER PERCENT CO2
>14
ENTER PERCENT CO
>0
ENTER PERCENT N2
>80
ENTER PERCENT O2
>6
ENTER AMBIENT PRESSURE, PAMBNT (INCHES HG)
>30.06
ENTER STACK PRESSURE RELATIVE TO AMBIENT, DPSTK (INCHES H2O)
>0
ENTER STACK TEMPERATURE, TSTACK (DEG F)
>280
ENTER STACK GAS VELOCITY, VSTACK (FT/SEC)
>1.0
ENTER IMPACTOR TEMPERATURE, TIMP (DEG F)
>280
WAS EPA METHOD 5 USED TO DETERMINE THE FLOW RATE? ENTER Y OR N
>N
ENTER NAME (<21 CHAR) OF METHOD USED
>UNKNOWN
ENTER IMPACTOR FLOW RATE, FLOW (ACFM, STACK COND.)
>0.358
ENTER PHYSICAL DIAMETER OF LARGEST PARTICLE COLLECTED, DMAX (MICRONS)
>49
ENTER NOZZLE DIAMETER, DNOZZ (INCHES)
>1.0
ENTER CUTPOINT OF NOZZLE, CUTNOZ (MICRONS) OR 0 (ZERO) FOR PADRE TO CALCULATE IT
>0
ENTER CUTPOINT OF CYCLONE, CYCL (MICRONS) OR 0 (ZERO) IF NONE USED
>0
ENTER NOZZLE/CYCLONE MASS, CMASS (MG)
>0
WAS BACKUP FILTER USED?  ENTER Y OR N.
>Y
DID BACKUP FILTER COLLECT LARGE PARTICLES?  ENTER Y OR N
>NO
DO YOU WANT TO INTERPOLATE MASS CONCENTRATIONS TO NON-STD. DIAM.?  ENTER Y OR N
>NO
ENTER IMPACTOR TYPE, IMPNAM
>ANDERSEN
ENTER IMPACTOR MODEL, IMPMOD
>UNKNOWN
ENTER PLATE SET ID, IPLATE, OR ZERO FOR GENERIC CALIBRATION
>3
ENTER NUMBER OF STAGES USED IN IMPACTOR, NS
>8
ENTER ID OF WEIGHT RECORD
>21
   *** MASS ON NOZZLE  IS LOW
DATA FOR RUN  1 BY RTI  AT RTP  ON  32183 HAS BEEN SAVED IN THE TRIAL DATA FILE

DO YOU WANT TO ENTER DATA OR TO MODIFY WEIGHT OR TEST DATA?  ENTER Y OR N
>N
```

Figure B-4. Entering run data.

```
DO YOU WISH TO RETRIEVE RUN DATA?  ENTER Y OR N
>Y
ENTER SITE ID, SITE, (4 CHAR) OR RETURN TO USE CURRENT VALUE
>
ENTER TEST DATE, IDATE (MMDDYY), OR RETURN TO USE CURRENT VALUE
>
ENTER THE RUN NO., IRUN, OR RETURN TO USE CURRENT VALUE
>
   *** MASS ON NOZZLE  IS LOW

DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>Y
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.    1
TEST COMMENTS       TCOMM= Demonstrate PADRE with sample Andersen data from CIDRS
 manual
PARTICLE DENSITY (GM/CC): RHO=     2.400

RUN COMMENTS:       RCOMM= Demonstrate PADRE's capability to accept free form com
ments
DATE OF RUN:         JDATE=  32383  AMBIENT PRESSURE (IN HG)          PAMBNT=  30.06
START TIME:         ISTART=   1000  STACK PRESS WRT AMBIENT (IN H2O):DPSTK=    .00
RUN DURATION (MIN):   DUR=   60.0  STACK GAS VELOCITY (FT/SEC):      VSTACK=   1.00
RUN TYPE:           RTYPE= 0       STACK TEMPERATURE (DEG F):       TSTACK=  280.0
% CARBON DIOXIDE:     CO2=   14.0  IMPACTOR TEMPERATURE (DEG F):       TIMP=  280.0
% CARBON MONOXIDE:    CO=     .0  MAX. PARTICLE DIAM. (MICRONS):      DMAX=   49.0
% NITROGEN:           N2=   80.0  CYCLONE CUT POINT (MICRONS):       CYCL=     .0
% OXYGEN:            O2=    6.0  NOZZLE DIAMETER (INCHES):         DNOZZ=  1.000
% WATER VAPOR:      H2O=    8.0  NOZZLE CUT POINT (MICRONS):       CUTNOZ=    .00
BACKUP FILTER USED?   BF= YES     LARGE PARTICLES ON FILTER?       FLARGE= NO
FLOW RATE DETERMINATION: METHOD=UNKNOWN
IMPACTOR TYPE:     IMPNAM=ANDERSEN IMPACTOR FLOW RATE (ACFM):        FLOW=   .358
IMPACTOR MODEL:    IMPMOD=UNKNOWN
IMP. PLATE SET ID:IPLATE=      3  SUBSTRATES ID:                    IDSUBS=    21
NO. IMP. STAGES USED  NS=      8  DESCR=GREASED FOIL
NO. JETS  DIAM.   CUMDP  CALIB          NOZZLE          .000 MG
  264     .1671  .0000   .3050          STAGE  1       1.220
  264     .1281  .0000   .4300          STAGE  2        .290
  264     .0953  .0000   .4100          STAGE  3        .580
  264     .0780  .0000   .3850          STAGE  4        .180
  264     .0547  .0000   .3410          STAGE  5       1.530
  264     .0359  .1760   .3200          STAGE  6       4.390
  264     .0269  .2940   .3310          STAGE  7       1.900
  156     .0253 1.0000   .2740          STAGE  8        .390
IMPACTOR DP SCALING FACTOR      1.287  FILTER          .540 MG

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>
```

Figure B-5. Reviewing run data.

```
DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>Y
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
    IRUN    RCOMM    JDATE    ISTART    DUR     RTYPE
>                     X        X         X
*** ANOTHER RUN WITH THIS ID ALREADY EXISTS
THE NEW RUN NO. IS              3
ENTER RUN COMMENTS
>This run propagated from #1
ENTER NEW VALUE FOR ISTART
>1200
ENTER NEW VALUE FOR DUR
>60
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
   PAMBNT    DPSTK   VSTACK   TSTACK    TIMP     DMAX     CYCL    DNOZZ    CUTNOZ   CMASS
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
    CO2       CO        N2        O2        H2O      NS     IDSUBS   ACUTPT
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
     BF     FLARGE   IMPNAM   IMPMOD   IPLATE    FLOW    METHOD
>
ENTER A MARK UNDER VARIABLE(S) YOU WISH TO MODIFY OR RETURN
    IRUN    RCOMM    JDATE    ISTART    DUR     RTYPE
>
   *** MASS ON NOZZLE  IS LOW
DO YOU WISH TO MODIFY THE INVALID VALUES?  ENTER Y OR N
>N
DATA FOR RUN  3 BY RTI  AT RTP  ON  32183 HAS BEEN SAVED IN THE TRIAL DATA FILE
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.   3
TEST COMMENTS       TCOMM= Demonstrate PADRE with sample Andersen data from CIDRS
 manual
PARTICLE DENSITY (GM/CC): RHO=    2.400

RUN COMMENTS:       RCOMM= This run propagated from #1
DATE OF RUN:        JDATE=  32383  AMBIENT PRESSURE (IN HG)          PAMBNT=  30.06
START TIME:        ISTART=   1200  STACK PRESS WRT AMBIENT (IN H2O):DPSTK=    .00
RUN DURATION (MIN):  DUR=   60.0   STACK GAS VELOCITY (FT/SEC):      VSTACK=   1.00
RUN TYPE:           RTYPE= 0       STACK TEMPERATURE (DEG F):       TSTACK=  280.0
% CARBON DIOXIDE:     CO2=   14.0  IMPACTOR TEMPERATURE (DEG F):     TIMP=  280.0
% CARBON MONOXIDE:    CO=     .0  MAX. PARTICLE DIAM. (MICRONS):     DMAX=   49.0
% NITROGEN:           N2=   80.0  CYCLONE CUT POINT (MICRONS):       CYCL=     .0
% OXYGEN:             O2=    6.0  NOZZLE DIAMETER (INCHES):         DNOZZ=  1.000
% WATER VAPOR:       H2O=    8.0  NOZZLE CUT POINT (MICRONS):      CUTNOZ=    .00
BACKUP FILTER USED?   BF= YES      LARGE PARTICLES ON FILTER?       FLARGE= NO
FLOW RATE DETERMINATION: METHOD=UNKNOWN
IMPACTOR TYPE:     IMPNAM=ANDERSEN IMPACTOR FLOW RATE (ACFM):        FLOW=   .358
IMPACTOR MODEL:    IMPMOD=UNKNOWN
IMP. PLATE SET ID:IPLATE=      3  SUBSTRATES ID:                   IDSUBS=     0
NO. IMP. STAGES USED  NS=      8  DESCR=GREASED FOIL
NO. JETS  DIAM.   CUMDP  CALIB          NOZZLE          .000 MG
  264    .1671   .0000   .3050          STAGE  1         .000
  264    .1281   .0000   .4300          STAGE  2         .290
  264    .0953   .0000   .4100          STAGE  3         .580
  264    .0780   .0000   .3850          STAGE  4         .180
  264    .0547   .0000   .3410          STAGE  5        1.530
  264    .0359   .1760   .3200          STAGE  6        4.390
  264    .0269   .2940   .3310          STAGE  7        1.900
  156    .0253  1.0000   .2740          STAGE  8         .390
IMPACTOR DP SCALING FACTOR     1.287   FILTER           .540 MG
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N
DO YOU WISH TO RETRIEVE A TEST?  ENTER Y OR N
>N
```

Figure B-6. Modifying run data.

```
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>Y

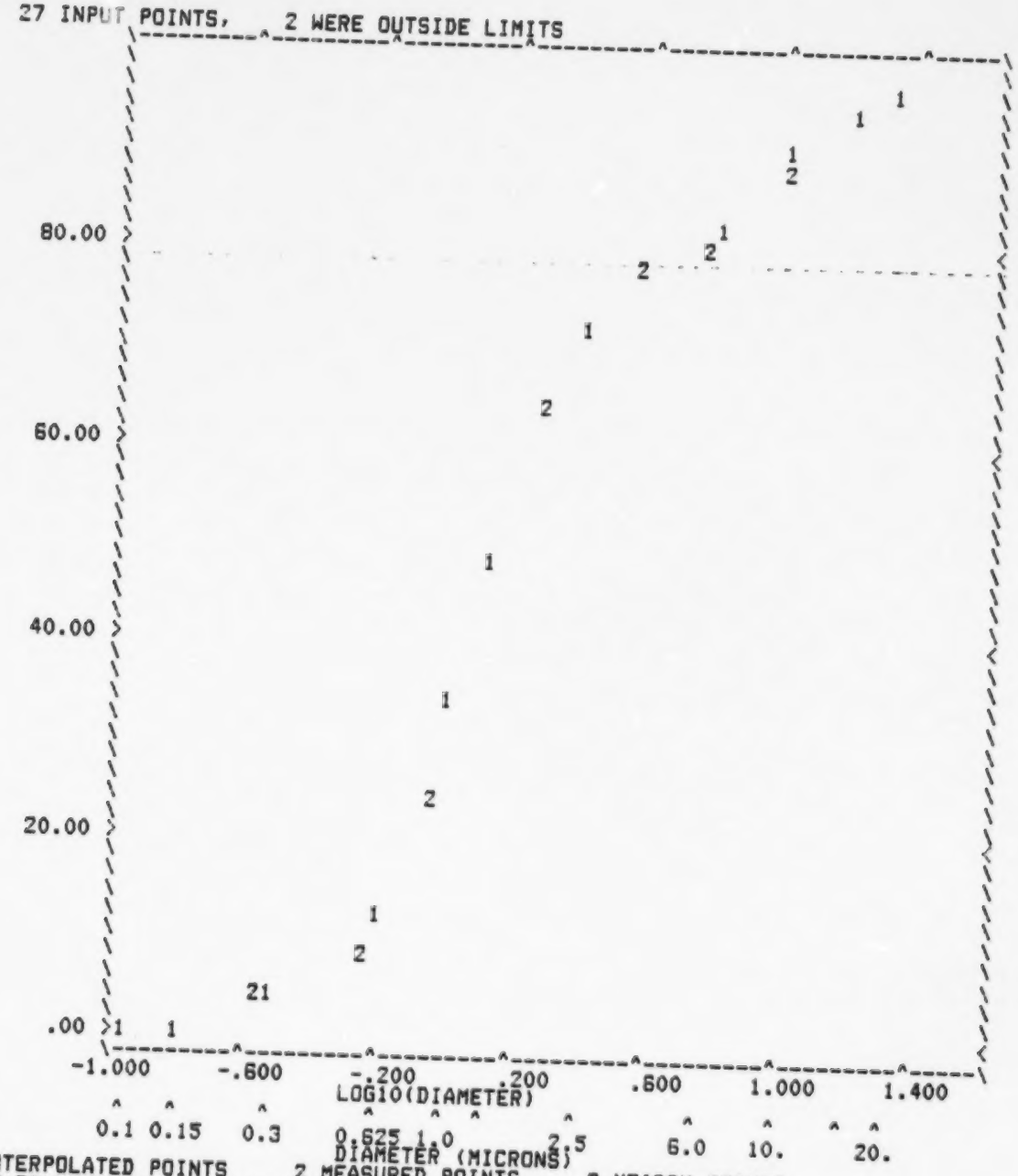


 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM     03/21/83          16:48:06
DATA FOR TEST BY CONTRACTOR RTI , AT SITE RTP , ON DATE  32183, RUN NO.  1
SAMPLING AT  109.4 % OF ISOKINETIC RATE
WANT TO SEE RESULTS USING CLASSICAL (STOKES) DEF. OF DIAM.?  ENTER Y OR N
>Y

Demonstrate PADRE's capability to accept free form comments
TOTAL MASS  7.9245-003  1.1979-002  1.8134+001  2.7412+001        DMAX=  49.0
              GR/ACF       GR/DNCF      MG/ACM       MG/DNCM             MICRONS

 STAGE       MASS       MASS    CUM. MASS       D50     GEO. MEAN DM/DLOGD  DN/DLOGD
             (MG)    (MG/DNCM) (MG/DNCM)  (MICRONS) (MICRONS) (MG/DNCM) (NO/DNCM)
NOZZLE        .01        .02      27.39      38.80      43.60  2.45-001  2.35+003
    1        1.22       3.03      24.36       9.16      18.85  4.84+000  5.74+005
    2         .29        .72      23.63       8.66       8.91  2.97+001  3.34+007
    3         .58       1.44      22.19       5.26       6.75  6.65+000  1.72+007
    4         .18        .45      21.75       3.62       4.36  2.77+000  2.65+007
    5        1.53       3.80      17.94       1.83       2.58  1.29+001  5.98+008
    6        4.39      10.91       7.03        .86       1.26  3.33+001  1.33+010
    7        1.90       4.72       2.31        .55        .69  2.37+001  5.84+010
    8         .39        .97       1.34        .27        .39  3.24+000  4.46+010
FILTER        .54       1.34                             .19  4.46+000  4.89+011
   *** CUT POINTS FOR STAGES -1  0 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  0 WITH D50=   38.80 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH D50=    8.66 OMITTED FROM INTERPOLATION
INTERPOLATED TO STD. INTERVALS: (VALUES AT DIAM. MARKED WITH * ARE EXTRAPOLATED)
                                  1.47        .30                  .00
                                  3.56        .63                 2.22+001
                                  9.72       1.00                 3.99+001
                                 13.28       1.25                 3.35+001
                                 20.15       2.50                 1.34+001
                                 22.76       6.00                 9.59+000
                                 24.69      10.00*                8.37+000
                                 25.95      15.00*                5.98+000
                                 26.59      20.00*                4.37+000
 WANT TO PLOT CUM. % MASS?  ENTER Y OR N
>Y
```

Figure B-7. Reducing run data.



1 INTERPOLATED POINTS 2 MEASURED POINTS 3 NEARBY POINTS
WANT TO SEE RESULTS USING THE TGLD DEF. OF AERO. DIAM.? ENTER Y OR N
>N
WANT TO SEE RESULTS USING MERCERS DEF. OF AERO. DIAM.? ENTER Y OR N
>N
DO YOU WANT EXPANDED OUTPUT MAILED TO YOU? ENTER Y OR N.
>Y

DO YOU WISH TO PRINT FPEIS CODING FORMS? ENTER Y OR N
>Y
PRINT DATA ON CODING FORMS FOR TEST BY RTI , AT RTP , ON 32183, RUN NO. 1
WANT TO RETRIEVE ANOTHER RUN? ENTER Y OR N

Figure B-7 (continued). Reducing run data.

```
 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM     03/21/83          14:48:06
DATA FOR TEST BY CONTRACTOR RTI , AT SITE FTP , ON DATE  32183. RUN NO.  1
TEST COMMENTS: DEMONSTRATE PADRE WITH SAMPLE ANDERSEN DATA FROM CIORS MANUAL
RUN COMMENTS  DEMONSTRATE PADRE'S CAPABILITY TO ACCEPT FREE FORM COMMENTS


IMPACTOR DESCRIPTION AND CALIBRATION

TYPE: ANDERSEN  PLATE SET ID:     1
MODEL: (MONTH    IMPACTOR DP SCALING FACTOR:      1.287
STAGE  NO.JETS  DIAM.  CUTOP   CALIB
   1     264    .1671   .0000   .3950
   2     264    .1101   .0000   .4300
   3     264    .0753   .0000   .4100
   4     264    .0709   .0000   .3830
   5     264    .0547   .0000   .3410
   6     264    .0359   .1760   .3200
   7     264    .0269   .2940   .3310
   8     154    .0253  1.0000   .2740

 IMPACTOR FLOWRATE =  .350 ACFM              IMPACTOR TEMPERATURE =  288.0 F (137.8 C)      SAMPLING DURATION =  60.00 MIN

 IMPACTOR PRESSURE DROP =  .198 IN. OF HG    STACK TEMPERATURE =  288.0 F (137.8 C)        STACK PRESSURE = 30.06 INCHES OF HG

 DRY GAS COMPOSITION (PERCENT)       CO2 = 14.00          CO =   .00          N2 = 80.00          O2 =  6.00          H2O =  0.00

 CALC. MASS LOADING = 7.9245-003 GR/ACF            1.1979-002 GR/DNCF          1.8134+001 MG/ACM          2.7412+001 MG/DNCM
SAMPLING AT  109.4 % OF ISOKINETIC RATE


 DIAMETERS ARE CALCULATED HERE ACCORDING TO THE CLASSICAL (STOKES) DEFINITION

 ASSUMED PARTICLE DENSITY = 2.400GM/CU.CM.       MAX. PARTICLE DIAMETER =  49.0 MICRONS


IMPACTOR STAGE                  NOZZLE      S1        S2        S3        S4        S5        S6        S7        S8      FILTER
STAGE INDEX NO.                    1        2         3         4         5         6         7         8         9        10

D50 (MICRONS)                   38.00      9.16      8.66      5.26      3.62      1.83      .86       .35       .27     .27/2.0
MASS (MG)                         .01      1.21       .29       .58       .18      1.53     4.39      1.98       .39       .54
MG/DNCM/STAGE                2.49-002  3.03+000  7.21-001  1.44+000  4.47-001  3.80+000  1.09+001  4.92+000  9.69-001  1.34+000
CUM. % OF MASS      < D50       99.91     88.85     86.22     80.96     79.33     65.46     25.66      8.43      4.90
CUM. MASS (MG/ACM)  < D50    1.61+001  1.61+001  1.56+001  1.47+001  1.44+001  1.19+001  4.65+000  1.53+000  8.88-001
CUM. MASS (MG/DNCM) < D50    2.74+001  2.64+001  2.36+001  2.22+001  2.17+001  1.79+001  7.03+000  2.31+000  1.34+000
CUM. MASS (GR/ACF)  < D50    7.92-003  7.04-003  6.83-003  6.42-003  6.29-003  5.19-003  2.03-003  6.68-004  3.88-004
CUM. MASS (GR/DNCF) < D50    1.20-002  1.06-002  1.03-002  9.70-003  9.50-003  7.84-003  3.07-003  1.01-003  5.86-004
GEO. MEAN DIA.(MICRONS)          4.36+001  1.89+001  8.91+000  6.75+000  4.36+000  2.58+000  1.26+000  6.86-001  3.86-001  1.94-001
DN/DLOGD (MG/DNCM)               2.45-001  4.84+000  2.97+001  6.65+000  2.77+000  1.29+001  3.33+001  2.37+001  3.24+000  4.46+000
DN/DLOGD (PARTICLES/DNCM)        2.35+003  5.74+005  3.34+007  1.72+007  2.65+007  5.90+008  1.33+010  5.84+010  4.46+010  4.89+011
   *** CUT POINTS FOR STAGES -1  0 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  0 WITH D50=   38.00 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH D50=    8.66 OMITTED FROM INTERPOLATION
 INTERPOLATED VALUES (VALUES AT DIAMETERS MARKED WITH * ARE EXTRAPOLATED)
 STD. DIA. (MICRONS)    .300      .625     1.000     1.250     2.500     6.000    10.000*   15.000*   20.000*
 CUM. MASS (MG/DNCM)   1.471     3.361     9.722    13.278    20.153    22.759    24.666    25.950    26.595
 DN/DLOGD (MG/DNCM)     .00   2.22+001  3.99+001  3.35+001  1.34+001  9.59+000  8.37+000  5.98+000  4.37+000

 NORMAL (ENGINEERING STANDARD) CONDITIONS ARE 21 DEG C AND 760MM HG.1
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Figure B-8. Expanded output: reduced data (at NCC).

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AERODYNAMIC DIAMETERS ARE CALCULATED HERE ACCORDING TO THE TASK GROUP ON LUNG DYNAMICS.

ASSUMED PARTICLE DENSITY = 1.00GM/CU.CM. MAX. PARTICLE DIAMETER = 75.9 MICRONS

IMPACTOR STAGE		NOZZLE	S1	S2	S3	S4	S5	S6	S7	S8	FILTER
STAGE INDEX NO.		1	2	3	4	5	6	7	8	9	10
D50 (MICRONS)		60.11	14.25	13.48	8.28	5.67	2.90	1.39	.90	.48	.48/2.0
MASS (MG)		.01	1.22	.29	.58	.18	1.53	4.39	1.90	.39	.54
MG/DNCM/STAGE		2.49-002	3.03+000	7.21-001	1.44+000	4.47-001	3.80+000	1.09+001	4.72+000	9.69-001	1.34+000
CUM. % OF MASS	< D50	99.91	88.85	86.22	80.96	79.33	65.46	25.66	8.43	4.90	
CUM. MASS (MG/ACM)	< D50	1.81+001	1.61+001	1.56+001	1.47+001	1.44+001	1.19+001	4.65+000	1.53+000	8.88-001	
CUM. MASS (MG/DNCM)	< D50	2.74+001	2.44+001	2.36+001	2.22+001	2.17+001	1.79+001	7.03+000	2.31+000	1.34+000	
CUM. MASS (GR/ACF)	< D50	7.92-003	7.04-003	6.83-003	6.42-003	6.29-003	5.19-003	2.03-003	6.68-004	3.88-004	
CUM. MASS (GR/DNCF)	< D50	1.20-002	1.06-002	1.03-002	9.70-003	9.50-003	7.84-003	3.07-003	1.01-003	5.86-004	
GEO. MEAN DIA.(MICRONS)		6.75+001	2.93+001	1.39+001	1.05+001	6.82+000	4.05+000	2.01+000	1.12+000	6.56-001	3.38-001
DM/DLOGD (MG/DNCM)		2.45-001	4.85+000	2.93+001	6.69+000	2.79+000	1.30+001	3.43+001	2.49+001	3.53+000	4.46+000
DM/DLOGD (PARTICLE/DNCM)		1.52+003	3.69+005	2.14+007	1.10+007	1.68+007	3.74+008	8.07+009	3.39+010	2.38+010	2.20+011

*** CUT POINTS FOR STAGES -1 0 ARE SIMILAR OR INVERTED
MEASURED DATA FOR STAGE, 0 WITH D50= 60.11 OMITTED FROM INTERPOLATION
*** CUT POINTS FOR STAGES 1 2 ARE SIMILAR OR INVERTED
MEASURED DATA FOR STAGE, 2 WITH D50= 13.48 OMITTED FROM INTERPOLATION

INTERPOLATED VALUES (VALUES AT DIAMETERS MARKED WITH * ARE EXTRAPOLATED)

STD. DIA. (MICRONS)	.625	1.000	1.250	2.500	6.000	10.000	15.000*	20.000*
CUM. MASS (MG/DNCM)	1.751	3.326	5.739	16.310	21.762	23.034	24.552	25.525
DM/DLOGD (MG/DNCM)	3.53+000	2.31+001	2.67+001	2.77+001	2.44+000	9.36+000	8.40+000	6.99+000

AERODYNAMIC DIAMETERS ARE CALCULATED HERE ACCORDING TO MERCER.

ASSUMED PARTICLE DENSITY = 1.00GM/CU.CM. MAX. PARTICLE DIAMETER = 75.9 MICRONS

IMPACTOR STAGE		NOZZLE	S1	S2	S3	S4	S5	S6	S7	S8	FILTER
STAGE INDEX NO.		1	2	3	4	5	6	7	8	9	10
D50 (MICRONS)		60.11	14.36	13.59	8.31	5.78	3.01	1.50	1.01	.58	.58/2.0
MASS (MG)		.01	1.22	.29	.58	.18	1.53	4.39	1.90	.39	.54
MG/DNCM/STAGE		2.49-002	3.03+000	7.21-001	1.44+000	4.47-001	3.80+000	1.09+001	4.72+000	9.69-001	1.34+000
CUM. % OF MASS	< D50	99.91	88.85	86.22	80.96	79.33	65.46	25.66	8.43	4.90	
CUM. MASS (MG/ACM)	< D50	1.81+001	1.61+001	1.56+001	1.47+001	1.44+001	1.19+001	4.65+000	1.53+000	8.88-001	
CUM. MASS (MG/DNCM)	< D50	2.74+001	2.44+001	2.36+001	2.22+001	2.17+001	1.79+001	7.03+000	2.31+000	1.34+000	
CUM. MASS (GR/ACF)	< D50	7.92-003	7.04-003	6.83-003	6.42-003	6.29-003	5.19-003	2.03-003	6.68-004	3.88-004	
CUM. MASS (GR/DNCF)	< D50	1.20-002	1.06-002	1.03-002	9.70-003	9.50-003	7.84-003	3.07-003	1.01-003	5.86-004	
GEO. MEAN DIA.(MICRONS)		6.75+001	2.94+001	1.40+001	1.05+001	6.93+000	4.17+000	2.12+000	1.23+000	7.65-001	4.12-001
DM/DLOGD (MG/DNCM)		2.45-001	4.82+000	3.01+001	6.76+000	2.83+000	1.34+001	3.61+001	2.72+001	4.00+000	4.46+000
DM/DLOGD (PARTICLE/DNCM)		1.52+003	3.67+005	2.11+007	1.07+007	1.62+007	3.63+008	7.20+009	2.81+010	1.74+010	1.22+011

*** CUT POINTS FOR STAGES -1 0 ARE SIMILAR OR INVERTED
MEASURED DATA FOR STAGE, 0 WITH D50= 60.11 OMITTED FROM INTERPOLATION
*** CUT POINTS FOR STAGES 1 2 ARE SIMILAR OR INVERTED
MEASURED DATA FOR STAGE, 2 WITH D50= 13.59 OMITTED FROM INTERPOLATION

INTERPOLATED VALUES (VALUES AT DIAMETERS MARKED WITH * ARE EXTRAPOLATED)

STD. DIA. (MICRONS)	.625	1.000	1.250	2.500	6.000	10.000	15.000*	20.000*
CUM. MASS (MG/DNCM)	1.447	3.361	4.742	15.737	21.755	22.987	24.524	25.511
DM/DLOGD (MG/DNCM)	.00	1.39+001	2.75+001	3.06+001	3.06+000	9.50+000	8.40+000	6.99+000

NORMAL (ENGINEERING STANDARD) CONDITIONS ARE 21 DEG C AND 760MM HG.1

Figure B-8(continued). Expanded output: reduced data (at NCC).

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```
DATA FOR TEST BY CONTRACTOR RTI  AT SITE RTP  ON DATE  32183  RUN NO.  1

                    E P A   E A D S   F P E I S          FORM 6

      1   1   2   2   3   3   4   4   5   5   6   6   7   7   8
  5   0   5   0   5   0   5   0   5   0   5   0   5   0   5   0
F         1H0D ANDERSEN  UNKNOWN   IMPACTOR 1000 60     138764 80 240   40
F          H1                                  1049MG

F          H2O                                 138764  101
F          H3   1400   0 6008000      1 4900     3

F          H5GREASED FOIL
F          H6DEMONSTRATE PADRE'S CAPABILITY TO ACCEPT FREE FORM COMMENTS


                    E P A   E A D S   F P E I S          FORM 7A

      1   1   2   2   3   3   4   4   5   5   6   6   7   7   8
  5   0   5   0   5   0   5   0   5   0   5   0   5   0   5   0
F          K5 1 STAGE  1        100E-02
F          K5 2 STAGE  2        122E+00
F          K5 3 STAGE  3        290E-01
F          K5 4 STAGE  4        580E-01
F          K5 5 STAGE  5        100E-01
F          K5 6 STAGE  6        153E+00
F          K5 7 STAGE  7        439E+00
F          K5 8 STAGE  8        190E+00
F          K5 9 FILTER          390E-01
```

Figure B-9. FPEIS coding forms (at NCC).

```
DO YOU WISH TO RETRIEVE RUN DATA?  ENTER Y OR N
>N
DO YOU WISH TO RETRIEVE A TEST?  ENTER Y OR N
>Y
ENTER SITE CODE, SITE (4 CHAR)
>COL
ENTER TEST DATE, IDATE, (MMDDYY)
>011376

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>Y
TEST BY RTI  AT COL  ON  11376  RHO= 2.40  TEST COMMENTS ARE
CIDRS SYSTEM TEST DATA: P362 FF.

INDEX TYPE DATE START DUR IDSUBS IMPACTOR     COMMENTS

  1    I   11376 1450  15. 292 BRIN  3 COLI-4 1-13-73 1450 4UAI: P364 CIDRS MAN
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  2    I   11376 1715  15. 472 BRIN  4 COLI-5 2UAI/P 365 CIDRS MANUAL.
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  3    I   11376 1822  15. 284 BRIN  1 COLI-7 10UAI/P. 366 CIDRS TESTING
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              8  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  4    I   11476 1520  15.  24 BRIN  1 COLI-10 1 UAI
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  5    I   11476 1600  15. 189 BRIN  4 COLI-12 5UAI/P 368
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  6    I   11576 1135  15. 419 BRIN  4 COLI-13 8UAI/P. 369 - TEST
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE

  7    O   11376 1630 120. 474 ANDE  3 COLO-19 PORTS 1,2,3/P 397 TEST.
   *** MASS ON NOZZLE  IS LOW

  8    O   11676 1336  90.  61 ANDE  2 COLO-31 PORTS 4,5,6/P. 398 TEST
   *** MASS ON NOZZLE  IS LOW

  9    O   11976 1544  84. 496 ANDE  4 COLO-37 PPORTS 4,5,6/PP. 399 TEST
   *** MASS ON NOZZLE  IS LOW

 10    O   12076  943 120.  78 ANDE  4 COLO-39 PORTS 1,2,3/P. 400 TEST
   *** MASS ON NOZZLE  IS LOW

 11    O   12076  945 120.  66 ANDE  5 COLO-40 PORTS 4,5,6/P. 401 TEST
*** WEIGHT RECORD            66 IS DELETED
   *** MASS ON NOZZLE  IS LOW
    ***** NET WEIGHTS HAVE NOT BEEN CALCULATED
*** DATA FOR THIS RUN IS INCOMPLETE.

*** RUN 12 BY RTI  AT COL  ON  11376 NOT FOUND
*** RUN 13 BY RTI  AT COL  ON  11376 NOT FOUND

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>N
 DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY?  ENTER Y OR N
>N
```

Figure B-10. Reviewing all runs in a test.

```
DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>1
THE PHYSICAL (STOKES) DIAMETER WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>2
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>IN

   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              1
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  5588.78
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              2
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  6409.47
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              8  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              3
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  6271.89
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              4
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  6268.68
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              5
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  6404.60
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN              6
   *** SAMPLING IS AT  10.1 % OF ISOKINETIC RATE
SAMPLING AT   10.1 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE      7
VALUE  6866.49
```

Figure B-11. Comparing several runs

```
   *** MASS ON NOZZLE  IS LOW
   *** MASS ON NOZZLE  IS LOW
   *** MASS ON NOZZLE  IS LOW
   *** MASS ON NOZZLE  IS LOW
*** WEIGHT RECORD            66 IS DELETED
   *** MASS ON NOZZLE  IS LOW
    ***** NET WEIGHTS HAVE NOT BEEN CALCULATED
*** DATA FOR RUN RTI   COL    11376   II IS INCOMPLETE AND CANNOT BE USED

TEST SITE      COL        COL        COL        COL        COL        COL
TEST DATE    11376      11376      11376      11376      11376      11376
RUN NUMBER       1          2          3          4          5          6
RUN DATE     11376      11376      11376      11476      11476      11576
START TIME    1450       1715       1822       1520       1600       1135
TOTAL MASS 6.739E+03 7.480E+03 4.203E+03 1.495E+03 3.077E+03 7.075E+03

STD. DIAM.   CUM. % MASS < D50
 3    .30        .48        .90        .22       1.32        .99        .55
 4    .63        .99       1.51       1.21       3.20       1.51        .78
 5   1.00       1.89       2.39       2.41       5.34       2.35       1.27
 6   1.25       2.75       3.09       3.44       6.35       2.84       1.88
 7   2.50       7.10       6.73       8.80      14.96       7.15       5.55
 8   6.00      14.07      13.55      19.04      24.66      13.74      12.10
 9  10.00      24.81      16.94      23.83      30.53      17.68      15.53
10  15.00      35.17      22.66      30.05      35.52      23.62      21.69
11  20.00      44.28      30.71      37.78      39.64      31.67      30.10

DATA COMPARISON FOR     6 INLET  RUNS BY RTI
STD. DIAM.   NO.   DM/DLOGD   CUMULATIVE          CUM. % MASS < D50
(MICRONS)   RUNS  (MG/DNCM)   MASS < D50    AVG.     STD. DEV.    MIN.      MAX.
 3    .30     6   7.99E+01   3.30E+01        .74        .40        .22      1.32
 4    .63     6   1.03E+02   6.33E+01       1.53        .87        .78      3.20
 5   1.00     6   3.39E+02   1.08E+02       2.61       1.41       1.27      5.34
 6   1.25     6   4.41E+02   1.46E+02       3.39       1.54       1.88      6.35
 7   2.50     6   1.12E+03   3.65E+02       8.38       3.39       5.55     14.96
 8   6.00     6   1.01E+03   7.35E+02      16.19       4.78      12.10     24.66
 9  10.00     6   1.51E+03   1.01E+03      21.55       5.81      15.53     30.53
10  15.00     6   2.76E+03   1.35E+03      28.12       6.32      21.69     35.52
11  20.00     6   3.70E+03   1.76E+03      35.70       5.76      30.10     44.28
DO YOU WANT TO PLOT CUM % MASS?  ENTER Y OR N
>Y
```

Figure B-11(continued). Comparing several runs.

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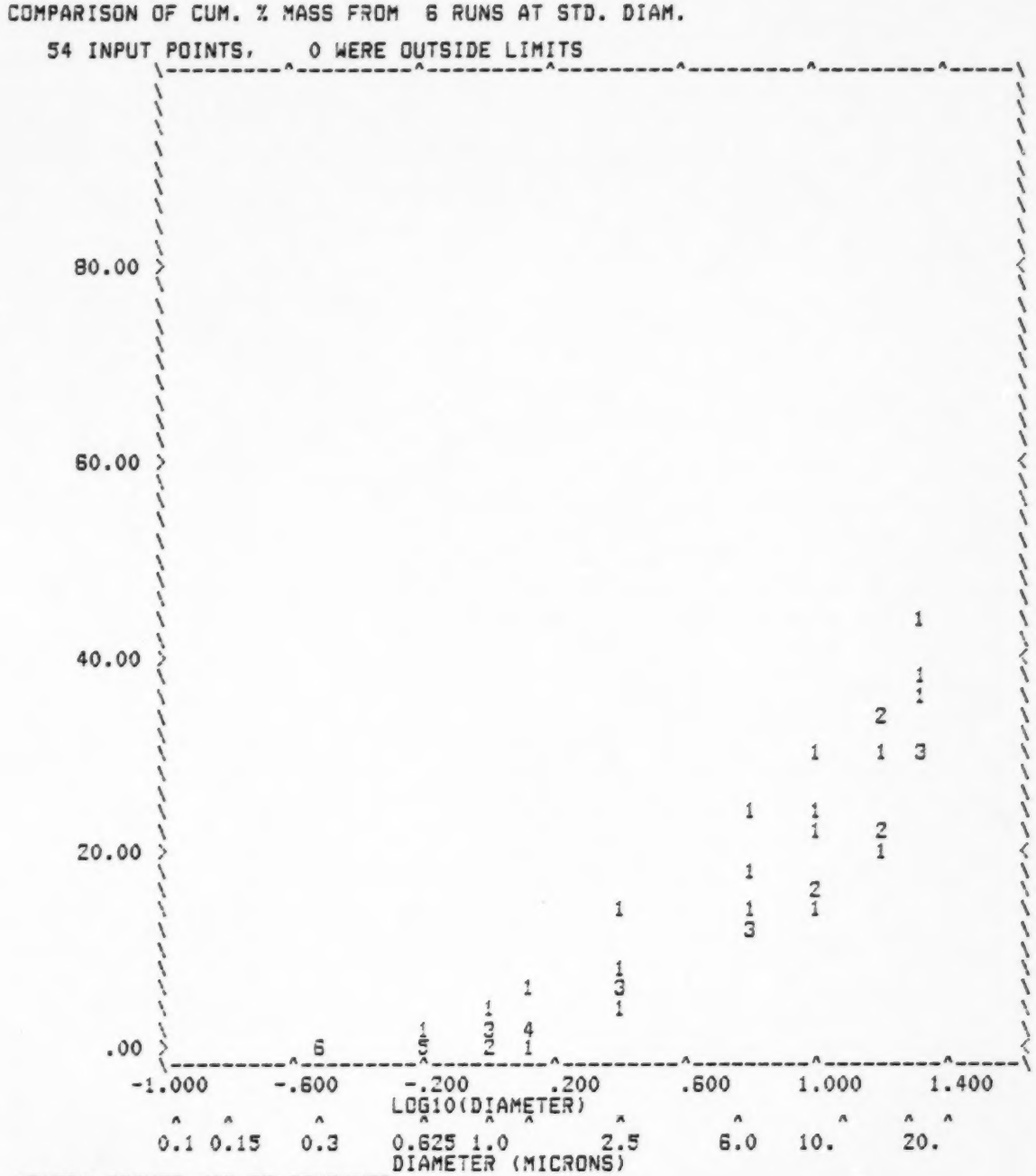

Figure B-11(continued). Comparing several runs.

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```
ENTER INDICES OF RUNS WHICH YOU WISH TO EXCLUDE, SEPARATED BY BLANKS
>4

TEST SITE      COL        COL        COL        COL        COL
TEST DATE    11376      11376      11376      11376      11376
RUN NUMBER       1          2          3          5          6

DATA COMPARISON FOR    5 INLET  RUNS BY RTI
STD. DIAM.   NO.   DM/DLOGD   CUMULATIVE          CUM. % MASS < D50
(MICRONS)   RUNS  (MG/DNCM)   MASS < D50    AVG.     STD. DEV.    MIN.      MAX.
 3    .30     5   8.80E+01   3.56E+01        .63        .32        .22       .99
 4    .63     5   9.25E+01   6.64E+01       1.20        .32        .78      1.51
 5   1.00     5   3.76E+02   1.14E+02       2.06        .48       1.27      2.41
 6   1.25     5   4.97E+02   1.56E+02       2.80        .58       1.88      3.44
 7   2.50     5   1.28E+03   3.93E+02       7.06       1.16       5.55      8.80
 8   6.00     5   1.13E+03   8.08E+02      14.50       2.65      12.10     19.04
 9  10.00     5   1.74E+03   1.12E+03      19.76       4.25      15.53     24.81
10  15.00     5   3.21E+03   1.52E+03      26.64       5.79      21.69     35.17
11  20.00     5   4.33E+03   1.99E+03      34.91       6.07      30.10     44.28
DO YOU WANT TO PLOT CUM % MASS?  ENTER Y OR N
>N
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS?  ENTER Y OR N
>N
 DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY?  ENTER Y OR N
>N

DO YOU WANT EXPANDED OUTPUT MAILED TO YOU?  ENTER Y OR N.
>N
```

Figure B-11(continued). Comparing several runs.

```
 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>N
 DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY?  ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>1
THE PHYSICAL (STOKES) DIAMETER WILL BE USED
ENTER INDICES OF RUNS TO BE USED, SEPARATED BY BLANKS, OR
ENTER 0 (ZERO) TO USE ALL RUNS IN THE TEST
>0

   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               1
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE         7
VALUE  5588.78
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               2
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE         7
VALUE  6409.47
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              8  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               3
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE         7
VALUE  6271.89
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               4
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE         7
VALUE  6268.68
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               5
   *** SAMPLING IS AT   9.5 % OF ISOKINETIC RATE
SAMPLING AT    9.5 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE         7
VALUE  6404.60
```

Figure B-12. Calculating penetration and efficiency.

```
   *** MASS ON STAGE              7  IS LOW
   *** MAX. PARTICLE DIAM., DMAX, IS LARGE
REDUCE DATA FOR RUN               6
   *** SAMPLING IS AT  10.1 % OF ISOKINETIC RATE
SAMPLING AT   10.1 % OF ISOKINETIC RATE
   *** JET VELOCITY > 5000 CM/SEC
STAGE          7
VALUE  6866.49
   *** MASS ON NOZZLE  IS LOW
REDUCE DATA FOR RUN               7
SAMPLING AT  122.5 % OF ISOKINETIC RATE
   *** MASS ON NOZZLE  IS LOW
REDUCE DATA FOR RUN               8
SAMPLING AT  126.8 % OF ISOKINETIC RATE
   *** MASS ON NOZZLE  IS LOW
REDUCE DATA FOR RUN               9
SAMPLING AT  121.0 % OF ISOKINETIC RATE
   *** MASS ON NOZZLE  IS LOW
REDUCE DATA FOR RUN              10
SAMPLING AT  125.3 % OF ISOKINETIC RATE
*** WEIGHT RECORD              66 IS DELETED
   *** MASS ON NOZZLE  IS LOW
    ***** NET WEIGHTS HAVE NOT BEEN CALCULATED
*** DATA FOR RUN RTI   COL    11376   11 IS INCOMPLETE AND CANNOT BE USED
  STD. DIAM.   PENETR.     ERR.    EFFICIENCY    ERR.
        .30     .05389    .04516     94.611     79.275
        .63     .14127    .08988     85.873     54.634
       1.00     .05582    .03880     94.418     65.626
       1.25     .04085    .03092     95.915     72.605
       2.50     .01273    .00977     98.727     75.791
       6.00     .03018    .02208     96.982     70.930
      10.00     .01453    .01219     98.547     82.661
      15.00     .00354    .00266     99.646     74.995
      20.00     .00117    .00111     99.883     94.947

DO YOU WANT EXPANDED OUTPUT MAILED TO YOU?  ENTER Y OR N.
>N

DO YOU WISH TO RETRIEVE DATA FROM ANOTHER TEST?  ENTER Y OR N
>N

DO YOU WISH TO RETURN TO THE BEGINNING OF PADRE? ENTER Y OR N
>N

DO YOU HAVE ANY COMMENTS ON THIS PROGRAM OR ITS DOCUMENTATION? ENTER Y OR N
>Y
PLEASE ENTER YOUR COMMENTS NOW.  ENTER RETURN WHEN YOU ARE FINISHED
>Enter comments on PADRE or its documentation while they are fresh in your mind
>
THANK YOU FOR YOUR COMMENTS
EXIT FROM PADRE
ENTER @FIN TO EXIT FROM THE UNIVAC
>@fin
```

Figure B-12(continued). Calculating penetration and efficiency.